

Service Manual

Synergy Systems

Synergy Tower, Notebook and Suite Systems Using the Patient Interface unit.

Also covers

Synergy T Series and Synergy N Series Systems Using the Plinth.

040W003 Issue A



For Medelec Synergy

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The Synergy range complies with:

- | | |
|------------------------------------|--|
| EN60601-1: 1990: | Medical electrical equipment Part 1: General requirements for safety. |
| EN60601-1-1:1993: | Collateral standard. Safety requirements for medical electrical systems. |
| EN60601-1-2:1993: | Collateral standard. Electromagnetic compatibility for medical electrical systems. |
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The Synergy range of multimedia EMG/EP systems bears the ETL Listing Mark, which is a Nationally Recognised Testing Laboratory (NRTL) Mark in the United States and Canada.



Note for the USA

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It should be noted that it is the user responsibility to ensure that conformance to EN 60601-1 Type BF, UL2601-1 and CSA C22.2 No. 601.1 patient isolation requirements are to be maintained when patient connected equipment or accessories not supplied by Oxford Instruments are used with Oxford Instruments equipment.

The connection of extra equipment to the patient or Synergy system could lead to the summation of leakage currents. In such circumstances the user must ensure that safe leakage currents are not exceeded.

Calibration. There is no special procedure for calibrating the Synergy.

For further information please refer to the Installation *Manual*.

Warning on batteries and safe disposal

PCs are fitted with a lithium backup battery. Should this battery need replacing it **MUST** be disposed of as per local regulations. These must not be recharged.

Notebook PCs have additional batteries.

All batteries **MUST** only be replaced by approved batteries of the same type.

Refer to PC manufacturers information and safety warnings in PC User Instructions.

Fire , Explosion and server burn hazard .

Do not recharge batteries that are not designed to recharged.

Do not disassemble.

Do not heat or incinerate

Do not expose contents to water.

Electromagnetic Compatibility

Make sure the environment in which Synergy is installed is not subject to strong sources of electromagnetic interference (e.g. radio transmitters, mobile phones).

This equipment generates and uses radio frequency energy. If not installed and used properly, in strict accordance with the manufacturer's instructions, it may cause or be subject to interference. Type-tested in a fully configured system, it has been found to comply with IEC601-1-2/EN60601-1-2, the standard intended to provide reasonable protection against such interference. Whether the equipment causes interference may be determined by turning the equipment off and on. If it does cause or is affected by interference, one or more of the following measures may correct the interference:

Reorienting the equipment

Relocating the equipment with respect to the source of interference

Moving the equipment away from the device with which it is interfering

Plugging the equipment into a different outlet so that the devices are on different branch circuits

Adding accessories or components to a system, or modifying a medical device or system, may degrade the immunity performance. Consult qualified personnel before making changes to the system configuration.

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IMPORTANT

As part of the process of continuous product improvement the content of this manual is liable to change without notice. This copy of the Service Manual is at Issue A. The chapters contained within it are at the following issues :-

Chapter Title	Issue
Standards Compliance	A
Certification	A
Trademarks	A
Screen Captures	A
Caution and Disclaimer	A
Installation Compliance	A
Warning on batteries and safe disposal	A
Electromagnetic Compatibility	A
Addresses	A
Table of Contents	A
Introduction	A
Technical Specification	A
Installation and Operation All Systems	A
Technical Overview PIU Systems	A
Technical Overview Plinth Systems	A
Patient Safety Checks PIU Systems	A
Patient Safety Checks Plinth Systems	A
System Functional Checks PIU Systems	A
System Functional Checks Plinth Systems	A
Firmware History	A
Fault Finding	A
Servicing PIU and Plinth Systems	A
Customer Options and Spares	A
Cable Management on trolley	Draft in progress
Index	A

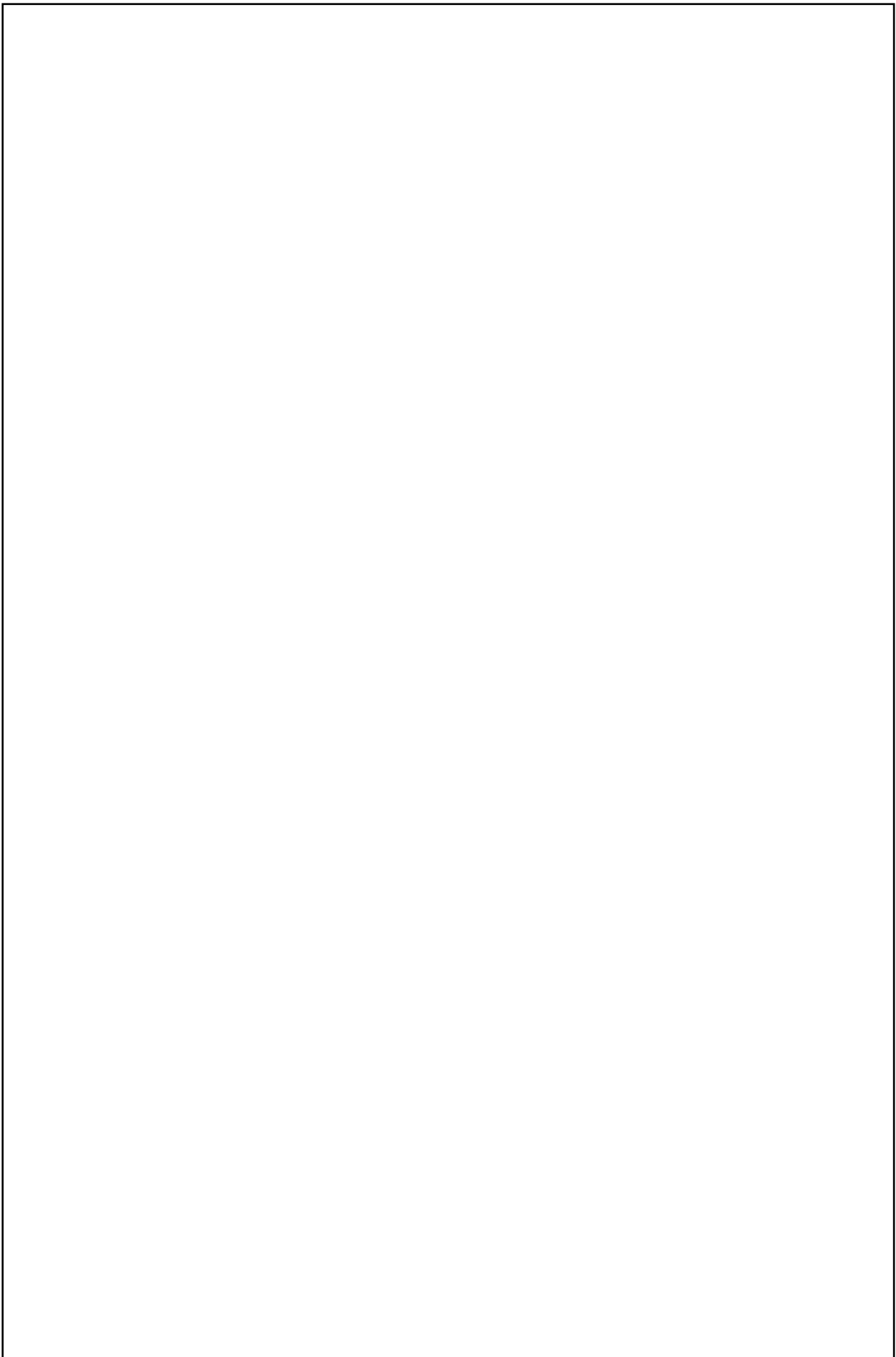


Table of Contents

INTRODUCTION	Chp 1-Pg 1
TECHNICAL SPECIFICATION PIU SYSTEMS	Chp 2-Pg 1
Tower or Notebook PC	Chp 2-Pg 1
Isolating Transformer ISO800 (Tower & Suite Systems)	Chp 2-Pg 1
Medical Grade Power Supply.	Chp 2-Pg 1
Amplifier in PIU	Chp 2-Pg 1
Software.	Chp 2-Pg 2
Sizes and Weights	
Notebook or Tower PC	Chp 2-Pg 3
Environmental	Chp 2-Pg 3
Safety Standards.	Chp 2-Pg 3
Quality Standards	Chp 2-Pg 3
TECHNICAL SPECIFICATION PLINTH SYSTEMS	Chp 3-Pg 1
Tower or Notebook PC	Chp 3-Pg 1
Isolating Transformer ISB100W for Plinth Tower Systems.	Chp 3-Pg 1
Mains Inlet to Plinth	Chp 3-Pg 1
Plinth Power Supply Specification	Chp 3-Pg 1
Amplifiers for use with Plinth system.	Chp 3-Pg 3
Electrical Stimulators in	
Control Panel or in	
Deluxe Probe (optional)	Chp 3-Pg 4
Plinth EP stimulator Specification	Chp 3-Pg 5
Software.	Chp 3-Pg 7
Sizes and Weights	
Notebook or Tower PC Plinth system	Chp 3-Pg 7
Environmental	Chp 3-Pg 7
Safety Standards.	Chp 3-Pg 8
Quality Standards	Chp 3-Pg 8
INSTALLATION AND OPERATION ALL SYSTEMS	Chp 4-Pg 1
Operating Restrictions:	
Cautions and Warnings	Chp 4-Pg 1
System Connection Diagrams	Chp 4-Pg 2
Key to Numbers used on the PIU System connection Drawings	Chp 4-Pg 6
Key to Numbers used on the PIU System connection Drawings.	Chp 4-Pg 7
Key to Numbers on the Synergy Plinth Systems	
connection Drawings	Chp 4-Pg 13
Symbols	Chp 4-Pg 16
Signal Cables	Chp 4-Pg 19

Installation	Chp 4-Pg 20
Notebook PIU System Mains Supply Cables and connections	Chp 4-Pg 20
Tower PIU System Mains Supply Cables and connections	Chp 4-Pg 21
Connecting PIU Systems.	Chp 4-Pg 21
Suite PIU Systems Mains Supply Cables and connections	Chp 4-Pg 22
Installing Plinth Systems.	Chp 4-Pg 22
Mains Inlet to Plinth	Chp 4-Pg 23
Connecting Plinth Systems	Chp 4-Pg 23
Brief Description of parts	Chp 4-Pg 23
Routine Maintenance.	Chp 4-Pg 23
Controls on the Patient Interface Unit.	Chp 4-Pg 24
Stim Probe	Chp 4-Pg 25
Notebook and Tower PC Connections	Chp 4-Pg 27
Connections on Patient Interface Unit.	Chp 4-Pg 29
Plinth Connections	Chp 4-Pg 31
TECHNICAL OVERVIEW PIU SYSTEM	Chp 5-Pg 1
Outline and scope of overview.	Chp 5-Pg 1
The PC	Chp 5-Pg 1
The Patient Interface Unit	Chp 5-Pg 3
Patient Interface Unit Overview	Chp 5-Pg 4
Amplifier Interface.	Chp 5-Pg 6
Amplifier electronics	Chp 5-Pg 7
Stimulator electronics	Chp 5-Pg 9
DC - DC CONVERTER	Chp 5-Pg 11
TECHNICAL OVERVIEW PLINTH SYSTEM.	Chp 6-Pg 1
Scope of Plinth overview.	Chp 6-Pg 1
The PC	Chp 6-Pg 2
.	Chp 6-Pg 3
The Plinth	Chp 6-Pg 3
Overview of the headboxes 2, 5 & 10 Channel	Chp 6-Pg 7
The Control Panel & Electrical Stimulators.	Chp 6-Pg 15
The EP Stimulator (Optional)	Chp 6-Pg 17
PATIENT SAFETY CHECKS FOR PIU SYSTEMS	Chp 7-Pg 1
Equipment Required	Chp 7-Pg 1
Initial Checks for all Systems	Chp 7-Pg 1
Signal Input Checks for all Systems	Chp 7-Pg 2

Internal EMG Stimulus Output checks for all Systems.	Chp 7-Pg 2
Notebook System Electrical Safety Tests	
Sections 7.5.0 to 7.12.0 inc.	Chp 7-Pg 4
Enclosure leakage current - Normal condition	Chp 7-Pg 5
Patient Leakage Current Tests	Chp 7-Pg 6
Patient Leakage Current Tests for External EMG Stimulator Probe . . .	Chp 7-Pg 7
Patient Auxiliary Current (Patient Amplifier inputs and Internal Stimulator)Chp 7-Pg 7	
Patient Auxiliary Current (Patient Amplifier inputs and External Stim Probe). .	Chp 7-Pg 8
Safety Checks EMG Internal Stimulator.	Chp 7-Pg 8
Safety Checks EMG External Stimulator Probe.. . . .	Chp 7-Pg 9
Tower System Electrical Safety Tests	
Sections 7.13.0 to 7.21.0 inc.	Chp 7-Pg 10
Earth bonding Tests	Chp 7-Pg 10
Enclosure leakage current - Normal condition	Chp 7-Pg 11
Patient Leakage Current Tests.	Chp 7-Pg 12
Patient Leakage Current Tests for External EMG Stimulator Probe . . .	Chp 7-Pg 13
Patient Auxiliary Current (Patient Amplifier inputs and Internal Stimulator)Chp 7-Pg 14	
Patient Auxiliary Current (Patient Amplifier inputs and External Stim Probe). .	Chp 7-Pg 14
Safety Checks EMG Stimulator	Chp 7-Pg 15
Safety Checks EMG External Stimulator Probe.	Chp 7-Pg 15
PATIENT SAFETY CHECKS FOR PLINTH SYSTEMS.	Chp 8-Pg 1
Equipment Required	Chp 8-Pg 1
Initial Checks for all Systems	Chp 8-Pg 1
Signal Input Checks for Plinth Systems.	Chp 8-Pg 2
Internal EMG Stimulus Output checks for Plinth Systems	Chp 8-Pg 3
Plinth System Electrical Safety Tests	
Sections 8.13.0 to 8.21.0 inc.	Chp 8-Pg 5
Earth bonding Tests	Chp 8-Pg 5
Enclosure leakage current - Normal condition	Chp 8-Pg 7
Patient Leakage Current Tests	Chp 8-Pg 8
Patient Leakage Current Tests for External EMG Stimulator Probe . . .	Chp 8-Pg 9
Patient Auxiliary Current (Patient Amplifier inputs and Internal Stimulator)Chp 8-Pg 10	
Patient Auxiliary Current (Patient Amplifier inputs and External Stim Probe)Chp 8-Pg 11	
Safety Checks EMG Stimulator	Chp 8-Pg 11
Safety Checks EMG External Stimulator Probe.	Chp 8-Pg 12
PIU SYSTEM FUNCTIONAL CHECKS	Chp 9-Pg 1

Equipment Required	Chp 9-Pg 1
System Connection	Chp 9-Pg 1
System Checks	Chp 9-Pg 1
CD-ROM Drive Checks	Chp 9-Pg 2
Patient Amplifier Checks	Chp 9-Pg 3
Trigger / Gain / Sweep Control Checks.	Chp 9-Pg 3
Parallel & Serial Port Checks	Chp 9-Pg 7
PLINTH SYSTEM FUNCTIONAL CHECKS	Chp 10-Pg 1
Equipment Required	Chp 10-Pg 1
System Connection	Chp 10-Pg 1
System Checks	Chp 10-Pg 1
CD-ROM Drive Checks.	Chp 10-Pg 2
Patient Amplifier Checks	Chp 10-Pg 3
Trigger / Gain / Sweep Control Checks	Chp 10-Pg 4
Triggering in / out for external sources and I/O INTERFACE (option)	Chp 10-Pg 9
Parallel & Serial Port Checks	Chp 10-Pg 10
EP Stim Checks	Chp 10-Pg 11
FIRMWARE HISTORY	Chp 11-Pg 1
Introduction	Chp 11-Pg 1
Firmware in Stimulator Probe	Chp 11-Pg 1
Firmware in Plinth	Chp 11-Pg 1
FAULT FINDING	Chp 12-Pg 1
Notebook System With PIU Fault Finding	Chp 12-Pg 1
Tower System With PIU Fault Finding	Chp 12-Pg 3
Suite System With PIU Fault Finding.	Chp 12-Pg 5
Notebook System With Plinth Fault Finding	Chp 12-Pg 6
Tower System With Plinth Fault Finding.	Chp 12-Pg 9
Fault Finding Network Problems With Plinth Systems.	Chp 12-Pg 12
SERVICING	Chp 13-Pg 1
Servicing Warnings	Chp 13-Pg 1
Patient Interface Unit	Chp 13-Pg 1
Synergy Plinth Unit	Chp 13-Pg 1
Warranty of PCs	Chp 13-Pg 1
Notebook's PC	Chp 13-Pg 1
Tower System.	Chp 13-Pg 1

CUSTOMER OPTIONS AND SPARES	Chp 14-Pg 1
Common Hardware Spares and Software to all systems	Chp 14-Pg 1
Spares for PIU Tower systems	Chp 14-Pg 2
Spares for Suite PIU System	Chp 14-Pg 2
Spares for Plinth Systems	Chp 14-Pg 3
Cable Management on the Trolley	Chp 15-Pg 1
Index	Chp 16

INTRODUCTION

These Synergy Systems are based around a PC, running under Windows. The system incorporates the latest advances in technology for portable neurodiagnostic systems.

Two different formats of Synergy system are covered in this service manual.

For safety warnings about the use of the PCs, refer the PC User Manual.

⚠ Before performing any service operations on the Synergy Systems, ensure that the unit is switched off, disconnected from the Isolating Transformer and mains supply.

⚠ Anti-static precautions must be observed when handling the boards in this system.

The systems incorporate 2, 5 or 10 amplifier channels for monitoring patient signals. EMG Stimuli can be delivered to the patient via either the internal electrical stimulators or the **optional Deluxe Stimulator** Probe. This hand held stimulator probe has its own controls for setting the stimulus intensity, duration, polarity and controlling acquisition.



THE PIU (Patient Interface Unit)

Synergy systems with **PIU** have the 2 channel patient Amplifier, control panel and EMG stimulator functions built into a single enclosure.

The **Plinth** system has in addition to the plinth, a small **control panel**, which contains a Control Panel pointing device and the Control Panel EMG electrical stimulator.

The plinth **system uses** the separate **5 or 10 channel Synergy Amplifier**.

Synergy systems with **Plinth** also have the option of the **visual** and **auditory EP Stimuli**.

The equipment is operated through dedicated controls on the (Patient Interface Unit PIU) or Control Panel. Also through the Graphical User Interface (GUI) using the built in mouse pointing device to access various screen "buttons".



The Plinth



CONTROL PANEL. Used with Plinth systems.

The systems may be supplied with a trolley, or stand however this is an optional extra with some systems.

It is possible to have Neurodiagnostic applications software running at the same time as other applications.

However, the performance may be affected if the other applications are demanding.

The correct system configuration e.g. the amount of memory installed, processor speed etc, can maximise the multitasking performance so it is essential that the system is configured according to the users requirements.

Two internal speakers are provided with these Notebook **PIU systems** to listen to the patient signals. Mains powered external speakers must not be used with the Synergy Notebook. Un-powered headphones or battery powered external speakers can be used but remember to switch them off after use.

With **Tower PIU Systems** two internal speakers are provided with in the monitor to listen to the patient signals. Also optional external speakers can be used.

With **Plinth Systems** two internal speakers are provided with in the plinth to listen to the patient signals.

Hard copies of patient data can be recorded on a suitable Oxford Instruments Medical Ltd approved external printer. Also an Oxford Instruments Medical Ltd approved external monitor can be connected to the Synergy Notebook System. Precautions must be taken to ensure that the safety of medical electrical equipment such as Synergy is not adversely affected by connection of these or any other peripherals. See section 3.2.5 on "Connecting other electrical equipment".

Patient data can be stored on the internal hard disk or floppy disks. An internal CD-ROM drive is fitted as standard to allow other Windows based software packages to be installed.

Communication with other systems can be made via an optional network card to allow transfer of patient data between systems.

The **Notebook PIU System** comes complete with the following items

- ♦ Notebook PC and Power Supply
- ♦ Oxford Instruments Power supply (Medical Grade)
- ♦ Patient Interface Unit which includes :-
Internal EMG stimulator
2 Channel Amplifier
External EMG stimulator Probe interface
USB control and interface
- ♦ Single footswitch
- ♦ Desk Mount for PIU

Optional items with **PIU Notebook** are :-

- ♦ External EMG stimulator Probe (optional)
- ♦ Arm and Stand
- ♦ Arm and Clamp
- ♦ Printer
- ♦ External Speakers
- ♦ Network card
- ♦ Network cable

The **Synergy PIU Tower** system comes complete with the following items

- ♦ Tower PC
- ♦ Isolating Transformer ISO-800
- ♦ Patient Interface Unit Which includes :-
Internal EMG stimulator
2 Channel Amplifier
External EMG stimulator Probe interface
USB control and interface
- ♦ Trolley and Arm
- ♦ Single footswitch
- ♦ External EMG stimulator Probe
- ♦ Appropriate Language Keyboard
- ♦ Mouse
- ♦ Monitor including built in speakers (optional)

Optional items with **PIU Tower system** are :-

- ♦ Printer
- ♦ Network card
- ♦ Network cable

The **Synergy PIU Suite** system comes complete with the following items

- ♦ Tower PC including Network card
- ♦ Notebook PC including Network card and Power Supply
- ♦ Isolating Transformer ISO-800
- ♦ Patient Interface Unit Which includes :-
Internal EMG stimulator
2 Channel Amplifier
External EMG stimulator Probe interface
USB control and interface
- ♦ Trolley and Arm
- ♦ Single footswitch
- ♦ External EMG stimulator Probe
- ♦ Appropriate Language Keyboard
- ♦ Mouse
- ♦ Monitor including built in speakers
- ♦ Desk Mount for PIU

Optional items with **Synergy Suite** are :-

- ♦ Printer
- ♦ Arm and stand (Notebook)

The **Notebook PLINTH System** comes complete with the following items

- ♦ Notebook PC
- ♦ Plinth which includes :-
Medical Grade Power supply
EP board (optional)
- ♦ DC to DC "Universal Auto/Air™ Power Adaptor" (Supplies DC power from Plinth to Notebook)
- ♦ Control Panel with internal EMG stimulator
- ♦ Amplifier of customers choice 2, 5 or 10 channel

Optional items with the **Notebook Plinth** are :-

- ♦ Isolating Transformer ISB-100W
- ♦ External EMG stimulator Probe (optional)
- ♦ Single footswitch
- ♦ Triple footswitch
- ♦ Arm and Stand

- ♦ Arm and Clamp
- ♦ Printer

The **Synergy Plinth Tower** system comes complete with the following items

- ♦ Tower PC
- ♦ Isolating Transformer ISB-100W
- ♦ Patient Interface Unit Which includes :-
Internal EMG stimulator
2 Channel Amplifier
External EMG stimulator Probe interface
USB control and interface
- ♦ Trolley and Arm
- ♦ Plinth which includes :-
Medical Grade Power supply
EP board (optional)
USB control and interface
- ♦ DC to DC "Universal Auto/Air™ Power Adaptor" (Supplies DC power from Plinth to Notebook)
- ♦ Control Panel with internal EMG stimulator
- ♦ Amplifier of customers choice 2, 5 or 10 channel
- ♦ Appropriate Language Keyboard
- ♦ Flat screen Monitor including

Optional items with **Tower system** are :-

- ♦ Printer
- ♦ Single footswitch
- ♦ Triple footswitch

A variety of applications software packages are available for installation in the Synergy Systems which will enable the user to perform their required clinical tests (see chapter 10). These can either be installed with the system when purchased or bought as an "add-on" at a later date.

Throughout this manual, the "pointing device" is the mouse or the built in pointing device in the Notebook PC or in the Plinth Control panel. When instructed to "click" on a button, this means move the pointer to the "button" icon referred to on the screen, and then press the left hand mouse button on the notebook PC .



Figure 1-1 Selecting “Help”

A knowledge of Windows is essential in order to be able to use the Synergy Systems. This information can be obtained from your Windows documentation, and from the many help screens available from within Windows. To call up the Windows help screen menu once the operating system has loaded, move the mouse pointer to the “task bar”. This is normally hidden but will appear when the mouse is moved to the very edge of the screen (the default setting is the bottom edge). If the task bar does not appear, press the “Ctrl” and “Esc” buttons on the keyboard together to show the start menu which will also make the task bar appear. When the “task bar” is displayed, click on the “Start” button on the task bar, and when a menu list appears, click on the “Help” button (see Figure 1.1).

The “Help Topics” window will then be displayed, and it is then a simple matter of following the on-screen instructions. If you want to search for a particular word in the help screens, click on the “Find” button. Follow the instructions on the screen to create a word database and then search for the required word.

Help screens are also available within individual applications software packages. The help menu is normally accessible by pressing the “F1” function key on the keyboard, or by calling it up from the menu toolbar using the mouse.

TECHNICAL SPECIFICATION PIU SYSTEMS

2.1 Tower or Notebook PC

As the Notebook or Tower PC supplied by Oxford Instruments will vary as newer and higher specification models appear please refer to the PC User Manual.

2.2 Isolating Transformer ISO800 (Tower & Suite Systems)

All parts of the Tower System must be powered from the outlets of the Isolating Transformer.

Before switching on check the following:-

- ♦ That the ISO800 is marked with the correct voltage for your local supply.

The ISO800 is factory set to either

230V input / 230V output

Or

115V input / 115V output

- ♦ That the input voltages of the **PC**, the **monitor** and the optional **printer** are all set to match the output voltage of the ISO800.
Refer to the rating labels and user manuals of these pieces of equipment to check if adjustments is necessary and for information on how to carry out any required adjustments.

Rated input voltage of the ISO800:
115V/230V.

Rated Supply frequency:50/60Hz

Maximum Peak Power Consumption: 840VA

The ISO800 Isolating Transformer has inlet fuses in both the Line and Neutral. These two fuses, are situated between the mains inlet and the on/off switch.

Fuses for the ISO800 Insulating Transformer

Mains Voltage	F3 and F4
115V	T10A L250V
230V	T6.3A L250V

2.3 Medical Grade Power Supply

This must be used to power the PIU.
Operates from mains inputs from 100V to 240V 50-60Hz. Maximum mains input current 1A.

The Power Supply provides an isolated DC output of +15V 3.3A

2.4 Amplifier in PIU

2.4.1 Input Channels

There are two Amplifier input channels on the Patient Interface Unit.

2.4.2 Amplifier Connections

Two red, two black 1.5mm touchproof sockets for +ve and -ve inputs. One green 1.5mm touchproof socket for neutral.
Two 5 pin DIN sockets with +ve, -ve, neutral and driven screens.

One 3.5mm jack socket for temperature probe input.

2.4.3 Performance

Input Impedance : 1000M Ω $\pm$ 10%
<30pF

CMRR: >110dB

Noise : <0.7 μ V r.m.s. (0.1 – 10kHz
bandwidth with inputs short circuited)

Differential offset range : > $\pm$ 2V

Common mode offset range : > $\pm$ 5V

2.4.4 Calibration Signal

1mV Squarewave Calibration signal generated when the amplifier of the Patient Interface Unit is switched off.

2.4.5 Sensitivity

Hardware gains of x10, x50, x500, and x2000 accurate to $\pm$ 5% within the PIU.

Sensitivities of 0.01 μ V to 100mV/div or per cm

2.4.6 Filters

The Hardware High and Low Pass filters are available via software control as follows :-

High Pass Filters

-6dB per octave with -3dB points at 0.1, 1, 3, 10, 20, 100 and 500Hz accurate to $\pm$ 10%

Low Pass Filters

-12dB per octave with -6dB points at 100, 200Hz, 500Hz, 1, 2, 3, 5 and 10kHz accurate to $\pm 10\%$.

Notch Filters

Frequency : 50 or 60Hz or OFF

2.4.7 Temperature Probe

Temperature Range 15°C to 40°C with 0.1°C resolution, 0.2°C accuracy for use with YSI series 400 or 4400 probes with resistance of 2253 Ω at 25°C. Reusable and Disposable types available (see chapter 10)
Note: Disposable types cannot be connected directly, an extension / adaptor cable is required.

2.4.8 Patient Interface Unit Cable Length

2.5 metres - connecting the USB (Universal Serial Bus) of the PC to the PIU. This cable also carries the DC power from the Synergy Power Supply to the PIU.

2.4.9 A to D Conversion Resolution

16 bits at all sampling rates.

2 Channel Headbox Sampling Rate

2 channels : 20 μ s/sample rate 50kHz

2.4.10 Data Storage Hard Disk

Interface : Enhanced IDE
Disk Size : At least 2GByte formatted
As the Notebook or Tower PC supplied by Oxford Instruments will vary as newer and higher specification models appear please refer to the notebook PC User Manual for drive details.

For storing the Windows operating system software and the Synergy Systems applications software and EMG test routines. Also used for storing trace data, patient data etc.

Floppy Diskette

Physical size : 3½" disk drive
Data capacity : 2MByte unformatted
1.44MByte unformatted

For installing the Windows operating system software (floppy version), the Synergy Systems applications software, and any upgrades.

CD-ROM

Interface : Enhanced IDE
Speed : At least 10 speed drive
As the Notebook or Tower PC supplied by Oxford Instruments will vary as newer and higher specification models appear please refer to the notebook PC User Manual for drive details.

For installing the Windows operating system software (CD-ROM version) and applications software. The CD-ROM drive is read only.

2.4.11 Electrical Stimulator in PIU

One internal stimulator or optional stimulator probe.

Constant voltage/constant current with low or high range.

Voltage Output : High Range - 0 to 300V
Low Range - 0 to 75V

Current Output : High Range - 0 to 100mA
Low Range - 0 to 25mA

Repetition Rates: Fine adjustment available up to 5pps.

Stim Duration : 0.05, 0.1, 0.2, 0.5, 1.0ms
Ranges in between those shown are software selectable.

Delay : ± 0 to 9 screen divisions

Stimulus modes: Single with PIU internal stimulator.

Bi-phasic with optional external stim probe only

Stim fail is reported for electrode impedance too high in current mode or too low in voltage mode.

2.5 Software**Standard Software**

The software is installed on all systems :-

- ♦ Full patient database with user-configurable fields (ODBC compliant)
- ♦ On-Line Report Generation software, Microsoft Office compatible

2.5.1 Language Support

The software is configurable to English (UK), English (US), French, German, Italian, Portuguese and Spanish.

2.6 Sizes and Weights Notebook or Tower PC

For size and Weight : Refer the Notebook's
PC User Manual.

PIU

Overall width : 156mm (6.2")
Overall height : 55mm (2.2")
Overall depth : 241mm (9.5")
System : 1kg (2.2lbs)

Trolley (optional on some Systems)

Overall width max: 730mm (28.75")

Trolley top height: 830mm (32.75")

Overall height
includes arm: 1300mm (51.25")

Depth: 580mm (23")Keyboard in
Max depth: 830mm(32.75")Keyboard out

Trolley : 31.5kg (69 lbs)
Trolley + arm : 33.2kg (72.75 lbs)

2.7 Environmental

2.7.1 Operating Conditions

Temperature range: +10 to 35°C

Humidity : 20 – 80% non-condensing
Atmospheric pressure:700mB to 1060mB

**Do not obstruct the cooling slots on the
Power Supply, the PC or on the PIU.**

**Position the instrument so that air
flows freely from the cooling slots.**

2.7.2 Storage or Transportation: Tolerable conditions:

Temperature range: -20 to 50°C
Humidity :10 – 80%
Atmospheric pressure:500mB to 1060m.

2.8 Safety Standards

EN60601-1 Type BF Applied Parts

UL2601-1 Type BF Applied Parts

CSA C22.2 No.601-1-M90 Type BF Applied
Parts

EN60601-1-1

EN60601-2-40.

EMC Standard: IEC601-1-2/EN60601-1-2

2.9 Quality Standards

CE Marked Product in compliance with the
Medical Devices Directive.

Manufactured under the following
approved Quality Management Systems :-

- ♦ ISO 9001:1994
- ♦ EN 46001:1993
- ♦ Also complies with FDA QSR / GMP
requirements

TickIT approved procedures for software
development.

TECHNICAL SPECIFICATION PLINTH SYSTEMS

3.1 Tower or Notebook PC

As the Notebook or Tower PC supplied by Oxford Instruments will vary as newer and higher specification models appear please refer to the PC User Manual.

3.2 Isolating Transformer ISB100W for Plinth Tower Systems.

All parts of the Tower Plinth System **must** be powered from the outlets of the Isolating Transformer.
This is an option with Notebook Plinth systems.

Before switching on check the following:-

- ♦ That the ISB100W is marked with the correct voltage for your local supply.

The ISB100W is factory set to either

230V input / 230V output

Or

115V input / 115V output

The **input voltage** setting is displayed in the window in the flap above the transformers on/off switch.

The **Output voltage** setting can be seen by looking at the position of the red switch on the back of the transformer.
Up is 115V output and down is 230V output.

If required because you are moving the system to an area with a different mains voltage. The input voltage can be altered by opening the flap above the on/off switch, removing the red fuse holder, turning it over then refitting.

The output voltage can be altered by changing the position of the red switch on the back of the transformer.

- ♦ That the input voltages of the **PC**, the **monitor** and the optional **printer** are all set to match the local mains voltage and the output voltage of the ISB100W.
Refer to the rating labels and user manuals of these pieces of equipment to check if adjustments is necessary and for information on how to carry out any required adjustments.

The **ISB-100W** is manufactured by the Toroid Corp of Maryland.

Rated input voltage of the ISB100W:
115V/230V.

Rated Supply frequency:50/60Hz

Maximum Peak Power Consumption:
1000VA

Fusing of ISB100W Isolating Transformer

The Mains inlet incorporate two fuses one in the Line and one in the neutrel to guard against catastrophic failure. Both fuses must be European and UL/CSA approval

Mains inlet Voltage	ISB100W FUSE RATING
115V	T10A AT L250V
230V	T5A AT L250V

3.3 Mains Inlet to Plinth

3.3.1 Fusing of Plinth

The Mains inlet incorporate two fuses one in the Line and one in the neutrel to guard against catastrophic failure. Both fuses must be European and UL/CSA approval

FUSE NUMBER	FUSE RATING
	100 - 240V
F1/F2 Mains inlet	T3.15A L250V

3.3.2 Power On/Off Switch & fuses

On/off switch and fuses are included in the Mains inlet module.

3.4 Plinth Power Supply Specification

3.4.1 Introduction

The power supply is incorporated into a plinth. The same plinth unit is be used for the **tower** and **notebook** PC variants.

This power supply is an open frame unit with heatsinking on the pcb and is designed to comply with medical safety standards.

3.4.2 Input Specifications

Classification

Class I - protectively earthed.

Input Voltage

Universal input - 90Vac to 264Vac

(i.e. a rated range of 100-240Vac +/-10%)

Input Frequency

47-63Hz

3.4.3 Output Specifications

Load range

O/P V	Min Load	Rated Load	Power W
+12V	0A	1.1A	13.2W
+12VPC*0A		7.5A	90W
-12V	0.1A	0.6A	7.2W
+5V	0.2A	0.6A	3W
+24V	0A	0.75A	18W
(2.1Apk)**		(50.4Wpk)**	
-24V	0A	0.55A	13.2W
(1.9Apk)**		(45.6Wpk)**	
+3.3V	0.8A	1.7A	5.61W

Total power 150.21W

Peak power 182.61Wpk**

Setting accuracy 0.25V on the controlled output and on +5V, 0.5V on 12V and 24V outputs, and 0.15V on +3.3V. For the +12VPC output see below.

* Output 2: This output runs from a secondary winding isolated from all other outputs. It is only used if the system includes a notebook PC, when it feeds an external dc-dc convertor which has an input voltage range of 11V minimum to 16V maximum. The nominal 12V level of output 2 can be set higher than 12V if it is felt that it would better suit the input range of the external dc-dc convertor. Supplier to recommend output voltage and setting accuracy for output 2.

** Peak current/power will not occur simultaneously on both +24V and -24V. Duty cycle for peak current is 10%. Duration of peak demand is typically 2ms.

All outputs other than output 2 may share a common 0V return.

No outputs have a direct connection to earth in the psu, capacitors are connected from the output returns to earth for EMC purposes.

The 24V supplies may have upto 3000µF connected across each supply external to the power supply.

Over Current Protection

Means are incorporated to fully protect the power supply from the effects of short circuit or overload on any dc output and to protect the load from excessive current.

Thermal Protection

Thermal shutdown is provided.

Cooling

The fan in the plinth is used to cool the Power supply and the other boards.

3.5 Amplifiers for use with Plinth system

3.5.1 Input Channels

There are two, five and ten channel variants of the headbox.

3.5.2 Headbox Connections Two Channel

Two red, two black 1.5mm touchproof sockets for +ve and -ve inputs. One green 1.5mm touchproof socket for neutral. Two 5 pin DIN sockets with +ve, -ve, neutral and driven screen.

One 3.5mm jack socket for temperature probe input.

Five Channel

18 grey 1.5mm touchproof sockets (12 cephalic in 10-20 format, 6 non-cephalic). Two green 1.5mm touchproof sockets for neutral.

Two 5 pin DIN sockets with +ve, -ve, neutral and driven screen.

Software montaging defines input switching.

One 3.5mm jack socket for temperature probe input

On 25 way D-type socket for remote jackbox connection

Ten Channel

18 grey 1.5mm touchproof sockets (12 cephalic in 10-20 format, 6 non-cephalic). Two green 1.5mm touchproof sockets for neutral.

Two 5 pin DIN sockets with +ve, -ve, neutral and driven screen.

Software montaging defines input switching.

One 3.5mm jack socket for temperature probe input

On 25 way D-type socket for remote jackbox connection

Headbox Cable Length

2.5metres standard detachable at mainframe and headbox.

3.5.3 Performance

Input Impedance: $1000M\Omega$ $<30pF$

CMRR: $>110dB$

Noise: $<0.7\mu V$ r.m.s. (0.1 – 10kHz bandwidth) with inputs connected to neutral through $5k\Omega$

Differential offset range: $>\pm 2V$

Common mode offset range: $>\pm 5V$

3.5.4 Impedance Test Two Channel

LED display in headbox, with an indication at <2 , <4 , <8 , <16 , <32 , and $>32k\Omega$

Accuracy: $\pm 0.5k\Omega$ between $2k\Omega$ and $5k\Omega$

Test Current: $<10\mu A$ a.c.

Electrode selection on headbox using push-buttons located adjacent to the touchproof input sockets.

Five and Ten Channel

Pass/Fail indication on headbox (by LED) and also on mainframe. Level selectable on headbox and at mainframe.

Accuracy: $\pm 0.5k\Omega$ between $2k\Omega$ and $5k\Omega$

3.5.5 Calibration Signal

Squarewave signal generated within the headbox at $5\mu V$, $50\mu V$, $500\mu V$, and $5mV$ pk-pk amplitude $\pm 10\%$

3.5.6 Sensitivity

Hardware gains of x10, x50, x500, and x2000 accurate to $\pm 5\%$ within the headbox.

Sensitivities of $2\mu V$ to $10mV$ in 2, 5, 10 steps available via software control using DSP.

3.5.7 Filters

Hardware High Pass filters at -6dB per octave with -3dB points at 0.01Hz, 0.1Hz, 0.3Hz, 1Hz, 3Hz, 10Hz, and 20Hz, accurate to $\pm 10\%$.

A D.C. setting is also available on the 5 channel headbox, with input offset removal for up to $\pm 500mV$ of offset.

All other filters available via software control using DSP as follows :-

High Pass Filters

-6dB per octave with -3dB points at 30, 50, 100, 200, 500Hz, 1 and 2kHz, and D.C.

Low Pass Filters

-12dB per octave with -6dB points at 50, 100, 200Hz, 1, 1.5, 2, 3, 5, 10, and 20kHz.

Notch Filters

Frequency: 50 or 60Hz, software switchable in and out

3.5.8 Temperature Probe

Temperature Range 15°C to 40°C with 0.1°C resolution, 0.2°C accuracy for use with YSI series 400 or 4400 probes with resistance of 2253Ω at 25°C. Reusable and Disposable types available (see chapter 10)

Note: Disposable types cannot be connected directly, an extension / adaptor cable is required.

3.5.9 A to D Conversion Resolution

16 bits at all sampling rates.

2 Channel Headbox Sampling Rate

2 channels: 20μs/sample 50kHz

5 Channel Headbox Sampling Rates

1–3 channels: 20μs/sample 50kHz

4 and 5 channels: 50μs/sample 20kHz

10 Channel Headbox Sampling Rates

1–3 channels: 20μs/sample 50kHz

4–10 channels: 50μs/sample 20kHz

3.5.10 Data Storage

Hard Disk

Interface : Enhanced IDE

Disk Size : At least 2GByte formatted

As the Notebook or Tower PC supplied by Oxford Instruments will vary as newer and higher specification models appear please refer to the notebook PC User Manual for drive details.

For storing the Windows operating system software and the Synergy Systems applications software and EMG test routines. Also used for storing trace data, patient data etc.

Floppy Diskette

Physical size : 3½" disk drive

Data capacity : 2MByte unformatted

1.44MByte unformatted

For installing the Windows operating system software (floppy version), the Synergy Systems applications software, and any upgrades.

CD-ROM

Interface : Enhanced IDE

Speed : At least 10 speed drive

As the Notebook or Tower PC supplied by Oxford Instruments will vary as newer and higher specification models appear please refer to the notebook PC User Manual for drive details.

For installing the Windows operating system software (CD-ROM version) and applications software. The CD-ROM drive is read only.

3.6 Electrical Stimulators in Control Panel or in Deluxe Probe (optional)

One internal stimulator or optional stimulator probe.

Constant voltage/constant current with low or high range.

Voltage Output : High Range - 0 to 300V
Low Range - 0 to 75V

Current Output : High Range - 0 to 100mA
Low Range - 0 to 25mA

Repetition Rates: Fine adjustment available up to 5pps.

Stim Duration : 0.05, 0.1, 0.2, 0.5, 1.0ms

Ranges in between those shown are software selectable.

Delay : ± 0 to 9 screen divisions

Stimulus modes: Bi-phasic with Control panel stimulator and also with optional Deluxe stim probe

Stim fail is reported for electrode impedance too high in current mode or too low in voltage mode.

3.7 Plinth EP stimulator Specification

The specification of the auditory and visual stimulator has evolved from EP Stimulators used in earlier Synergy products.

The output stage has reduced the background noise for signal intensities of 70dB and above.

3.7.1 Auditory Stimulator - Detailed specification

Clicks

Variable duration 0.05 to 1.0 ms in 0.01 ms (nominal) steps

Positive, Negative or Alternating Polarity.

Pips and Tone Bursts

Frequency : 0.125, 0.25, 0.5, 0.75, 1, 1.5, 2, 3, 4, 6, 8, 12kHz

Pip plateau duration : variable, 1 to 999 cycles in steps of 1 cycle.

Pip rise and fall duration : variable, 1 to 255 cycles in steps of 1 cycle.

Tone burst plateau duration : variable, 1 to 2000 ms in steps of 1 ms. Duration tolerance to be 0.1ms or better up to 100ms, to nearest half-cycle above 100ms. Continuous tones provided. Continuous tones limited in intensity at the highest level which will not cause thermal shutdown of the output amplifiers. Heatsinking is applied so as to maximise this level.

Tone bursts rise and fall duration : variable, 1 to 255 ms in steps of 1 ms. Duration tolerance as for plateau.

Envelope : User selectable - none (step), linear, Hanning, Gaussian, Blackman

Polarity : Positive, Negative or Alternating

Noise Sources

Ipsilateral and Contralateral white noise available for all stimulus types.

Ipsilateral and Contralateral narrow band filtered noise to IEC645 for all stimuli types except for clicks. Centred on stimulus frequency and typically between one third of an octave and one half octave wide.

Masking intensity to -40 to + 10 dB related to the stimulus.

Ipsilateral and Contralateral notch filtered noise for all stimulus types except for clicks. Centred on stimulus frequency and typically between one third of an octave and one half octave wide.

Where Ipsilateral noise is used on both outputs during bilateral stimulation, the noise output voltage is the same on both output channels. Where the output transducers show a sensitivity difference on calibration, the noise will be generated at half-way (on a decibel scale) between the required output levels for the two outputs, to an accuracy of 0.5dB.

In Threshold tests, where right/left subjective hearing level compensation is used, the use of Ipsilateral masking on bilateral stimulation will not be permitted.

Stimulus Intensity

Tone/Pip from 0 to 120 dBHL or from 0 to 132 dB SPL.

Click from 0 to 110 dBHL or from 0 to **137** dB SPL.

Adjustment in steps of 1dB, to an accuracy of ± 0.5 dB.

Calibration

Intensity calibration is to be available to the user under software control as at present.

Separate calibrations are to be available for nHL and SPL, but only the SPL calibration will be saved on the board.

Calibration can be saved for at least four transducers, so that different transducer types can be used on the same instrument (e.g. headphones, insert earphone and bone transducer) and is retained on software update.

The unit is provided a facility for field re-calibration of transducers. This requires the use of a specialised calibrated sound level and artificial ear. These items are not provided by Oxford Instruments.

Minimum transducer impedance will be 8 ohms.

Microphone

Microphone input is provided.

When the microphone is active the software blocks other audio signal outputs.

Output level can be set and saved separately in 5dB steps.

Activated on command from host system.

External Stimulus and Trigger Inputs

External audio signal inputs provided for the stimulus and masking signals. When the external masking signal is used, bandpass or notch filtering can be optionally applied.

When the external stimulus signal is used, this must be externally synchronised to the trigger signal provided.

Two stimulus trigger inputs are provided, each is separately configurable as audio, video or LED trigger.

Two stimulus type inputs determine the type of the next stim, plus a stim-in-progress output. (this enables mixed-mode P300 with frequent, rare and novel stimuli in differing modes)

Failure Detection

A means of failure detection is not provided, so that in the case of invalid setup of the waveform generator, audio waveform generation will be terminated to protect the patient from excessive output levels.

3.7.2 Visual Stimulator

Stimulation Pattern

Checkerboard, horizontal bars, vertical bars.

Sinusoidal as well as sharp transitions between light and dark are provided for bar patterns.

Optionally frame locked or non frame locked output.

Number of squares or bars : 8, 16, 32, 64, 128, 256.

Squares to be 1:1 aspect ratio.

Central Fixation Point

Central red square, size is selectable from 2, 4, 6, or 8 times size of 1/128 square.

Stimulus Fields

Full, half (left, right, upper, lower), individual quadrant, Peripheral, Foveal.

Change from foveal to peripheral region is selectable from {1/8, 1/4 & 3/8} of screen width from edge.

Non-stimulus quadrants are to be grey.

Visual Presentation

Reversal, onset/offset (full-field, partial fields and left/right/both), triggered by stimulus request.

Reversal Trigger mode - full and partial fields

Reverse during active period of trigger, otherwise Normal.

Left/Right/Both reversal Trigger mode

Step through [Reverse Left, Reverse Both, Both Normal] on leading edge of trigger.

Onset/Offset Trigger mode - full and partial fields

Onset during active period of trigger, otherwise Offset.

Left/Right/Both onset/offset Trigger mode

Step through [Left, Off, Right, Off, Both, Off] on on leading edge of trigger

Monitor Compatibility

SVGA standard (1024x768), non-interlaced **70Hz frame rate.**

Output socket will be a VGA 15-pin connector.

Four discrete contrast levels (20%, 40%, 60%, 100%).

LED Goggle Interface

As on existing synergy products.

Failure Detection

This is not considered necessary for the Visual Stimulator.

3.7.3 Compliance

The stimulator complies with the following standards

EN60601-1, EN60601-2-40 - Medical Safety

EN60601-1-2 EMC (Medical)

UL2601-1 - Medical Safety

CAN/CSA 22.2 No.601.1 - Medical Safety

In addition, the stimulator is designed in accordance with the principles of the IEC 645 Audiometer standard for Type 1 audiometers.

3.8 Software

Standard Software

The software is installed on all systems :-

- ♦ Full patient database with user-configurable fields (ODBC compliant)
- ♦ On-Line Report Generation software, Microsoft Office compatible

3.8.1 Language Support

The software is configurable to English (UK), English (US), French, German, Italian, Portuguese and Spanish

3.9 Sizes and Weights Notebook or Tower PC Plinth system

For size and Weight : Refer to the PCs User Manual.

Plinth

Overall width : 312mm (12.5")

Overall height : 68mm (2.75")

Overall depth : 292mm (11.5")

Plinth : 3.25kg

Control Panel

Overall width : 200mm (7.75")

Overall height : 50mm (2.")

Overall depth : 126mm (5")

Control Panel : 0.65kg

Trolley (optional on some Systems)

Size and Weight vary with type of trolley

3.10 Environmental

3.10.1 Operating Conditions

Temperature range: +10 to 35°C

Humidity : 20 – 80% non-condensing

Atmospheric pressure: 700mB to 1060mB

Do not obstruct the cooling slots or fans.

Position the instrument so that air flows freely from the cooling slots.

**3.10.2 Storage or Transportation:
Tolerable conditions:**

Temperature range: -20 to 65°C
Humidity :10 – 85%
Atmospheric pressure:500mB to 1060m.

3.11 Safety Standards

EN60601-1 Type BF Applied Parts

UL2601-1 Type BF Applied Parts

CSA C22.2 No.601-1-M90 Type BF Applied Parts

EN60601-1-1

EN60601-2-40.

EMC Standard: IEC601-1-2/EN60601-1-2

3.12 Quality Standards

CE Marked Product in compliance with the Medical Devices Directive.

Manufactured under the following approved Quality Management Systems :-

- ♦ ISO 9001:1994
- ♦ EN 46001:1993
- ♦ Also complies with FDA QSR / GMP requirements

TickIT approved procedures for software development.

INSTALLATION AND OPERATION ALL SYSTEMS

BEFORE USING THE EQUIPMENT FOR THE FIRST TIME, IT IS ESSENTIAL THAT CAUTIONS AND WARNINGS IN THIS CHAPTER ARE READ AND UNDERSTOOD.

4.1 Operating Restrictions: Cautions and Warnings

The cautions and warnings contained in this Service Manual must be observed by the user to ensure safe operation and to maintain the instrument in a safe condition.

4.1.1 Attention

The "attention" symbol  which appears on the instrument means "refer to accompanying documents". The symbol is repeated at relevant points in the manual and particular attention should be paid to the marked paragraphs.

4.1.2 Compliance with EN60601-1

This equipment complies with the following classifications according to EN60601-1

Class I equipment

Type BF equipment

Ordinary equipment (enclosed equipment without protection against ingress of water)

Equipment not suitable for use in presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide

Mode of operation – Continuous

Note for PIU systems:

To comply with patient safety requirements the Patient Interface Unit (PIU) must only be powered from the Oxford Instruments Power Supply 035C005.

THIS APPLIES FOR ALL CONFIGURATIONS OF SYSTEM WITH A PIU, i.e. TOWER, NOTEBOOK and SUITE SYSTEM.

The PIU must not be powered from any other power supply.

In the Tower PIU System configuration the Oxford Instruments Power Supply and any other mains powered equipment * MUST ALL BE POWERED FROM THE ISOLATED OUTPUTS OF THE ISO 800 ISOLATION TRANSFORMER.

***Supplied by Oxford Instruments**

Note for Notebook Plinth systems:

To comply with patient safety requirements the Notebook PC must only be powered from the DC to DC "Universal Auto/Air™ Power Adaptor" (Supplies DC power from Plinth to Notebook).

The Notebook PC must not be powered from any other power supply.

For Tower Plinth systems:

To comply with patient safety requirements the Plinth and any other mains powered equipment * MUST ALL BE POWERED FROM THE ISOLATED OUTPUTS OF THE ISB100W ISOLATION TRANSFORMER.

***Supplied by Oxford Instruments**

To comply with patient and user safety requirements you must read the relevant section in this manual. (See section 4.2.4)

4.1.3 Handbook Scope

The information contained in this Service Manual should enable a qualified electronic technician to verify the functioning of the unit, and to fault find to subassembly level. Some circuit details are provided in this manual but as the majority of the components used within the PIU, Plinth, control Panel and in the Amplifiers are SMT (surface mount technology) devices, **it is strongly recommended that any defects in the SMT circuits be rectified by subassembly replacement.** To assist with this, fully tested replacement subassemblies are available from *Oxford Instruments* and principal distributors.

Block diagrams of the circuits are provided with a brief description in later chapters as an aid to understanding the function of each part of the system.

Please note that only minimal information has been included for those items from OEM suppliers used with the Synergy Systems, as these have to be returned to the suppliers for repair if a fault occurs. Only certain upgrades of the Notebook PC or Tower PC are possible, by a qualified electronic technician, without the need to return it to the manufacturers or their representatives. See service section and PC user information.

4.2 System Connection Diagrams

4.2.1 Notebook PIU System Connection

Multiple portable socket outlets must not be used.

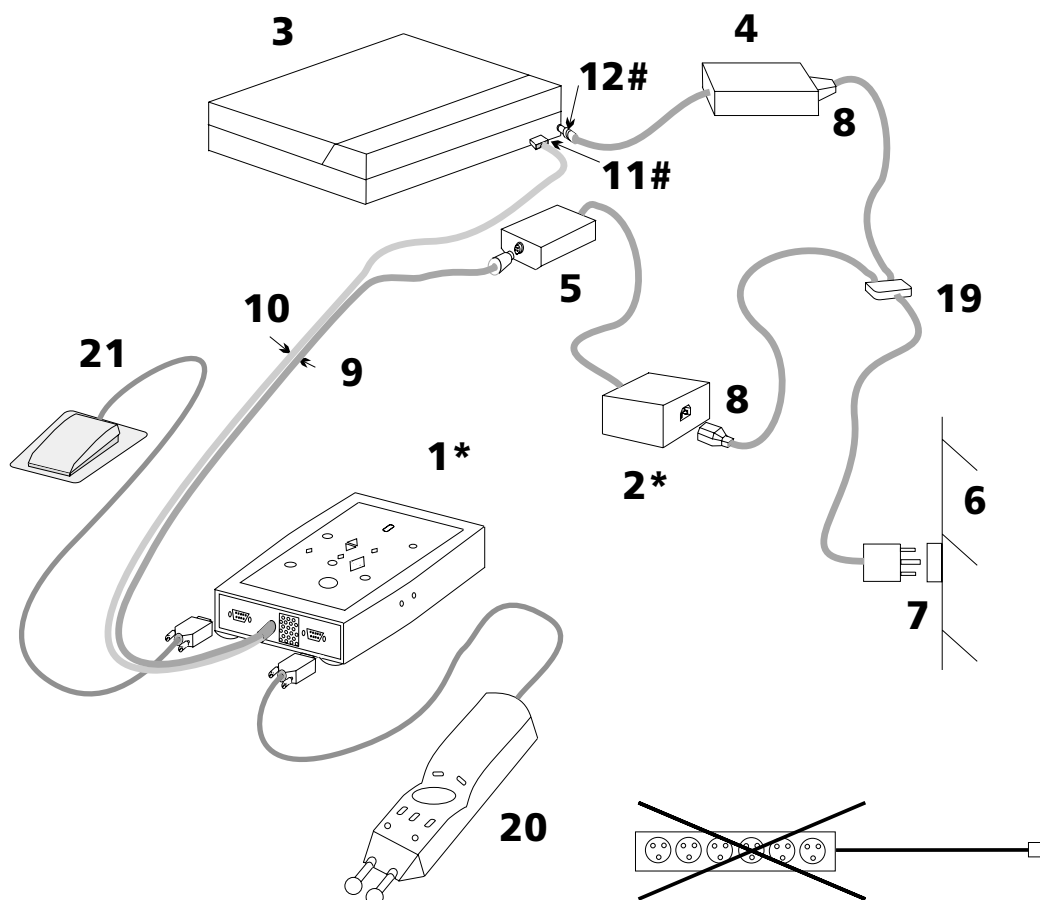
Refer to notebook PC user manual to determine the position of the input/output connectors.

***** The Patient Interface Unit (PIU) must only be powered from the Synergy Power Supply 035C005. The PIU must not be powered for any other power supply.

Only the Oxford Instruments Approved Printer may be connected to this system

All parts of the synergy notebook System with PIU shown in the diagram above may be used in the patient environment.

For key to item number used please refer to Chapter 4 page 6 or 7



4.2.2 Synergy Tower PIU System Connections

Multiple portable socket outlets must not be used.

Refer to PC user manual to determine the position of the input/output connectors.

* The Patient Interface Unit (PIU) must only be powered from the Synergy Power Supply 035C005. The PIU must not be powered for any other power supply.

- Separate Fixed Mains Socket Outlets Must Be Used

The maximum permitted load for the ISO800 Mains Isolating Transformer is 840VA.
The ISO800 Mains Isolating Transformer must not be placed on the floor.
It should only be mounted using the metal strap provided on the lower shelf of the system trolley.

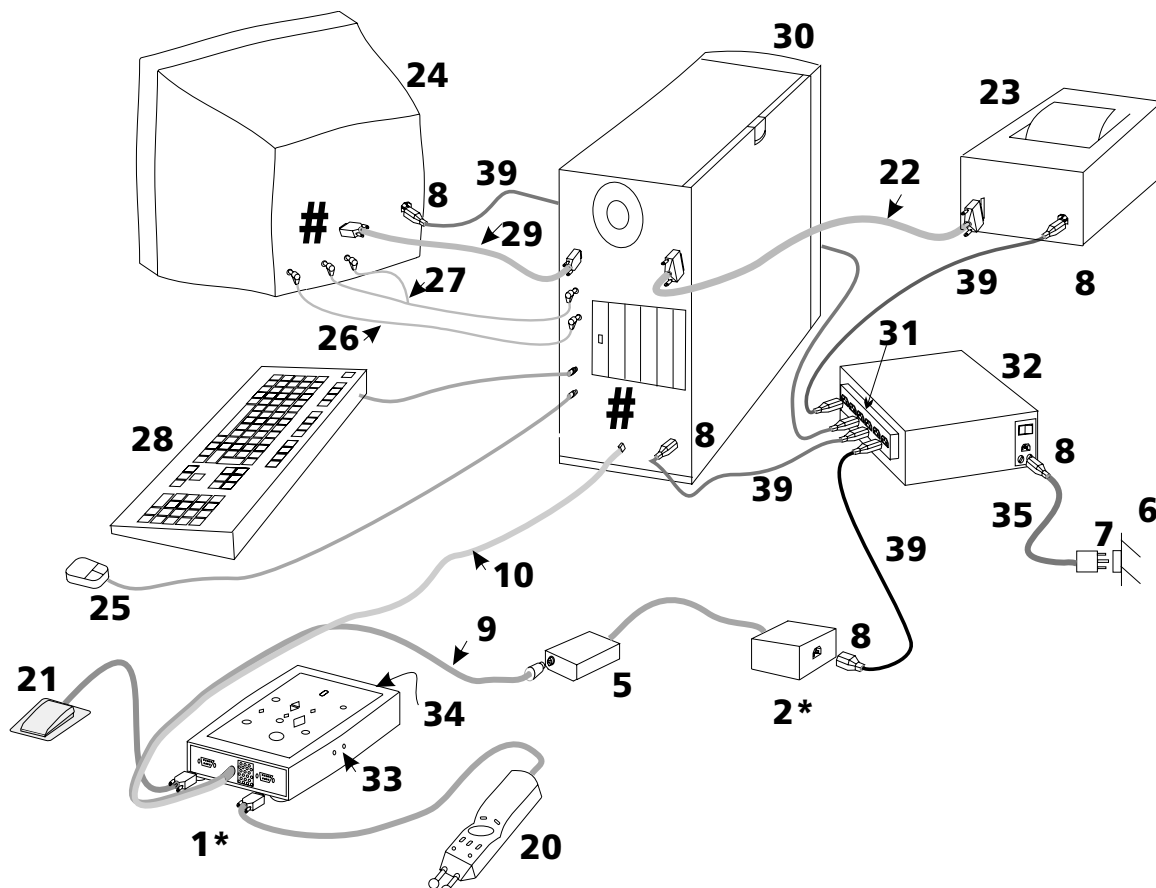
The Oxford Instruments Approved non-medical equipment supplied with the Synergy Tower system - the PC tower, the monitor and the optional printer must only be powered from the outlets of the ISO800 Mains Isolating Transformer.

If non-medical equipment supplied with the tower system were to be connected directly to a wall socket outlet then there may be a risk of the allowable leakage currents being exceeded.

Note that only PC cards and drives approved by Oxford Instruments Medical Ltd may be fitted into the PC tower.

For key to item number used please refer to Chapter 4 page 6 or 7

For Tower System step by step cable management on the trolley and connection diagrams see chapter 15.



4.2.3 Synergy Suite PIU System Connections

Multiple portable socket outlets must not be used.

- # Refer to PC user manual to determine the position of the input/output connectors.
- * The Patient Interface Unit (PIU) must only be powered from the Synergy Power Supply 035C005. The PIU must not be powered for any other power supply.
- Separate Fixed Mains Socket Outlets Must Be Used

The maximum permitted load for the ISO800 Mains Isolating Transformer is 840VA. The ISO800 Mains Isolating Transformer must not be placed on the floor. It should only be mounted on the cradle provided on the lower shelf of the system trolley. The non-medical equipment supplied with the Synergy Tower system - the PC tower, the monitor and the optional printer must only be powered from the outlets of the ISO800 Mains Isolating Transformer.

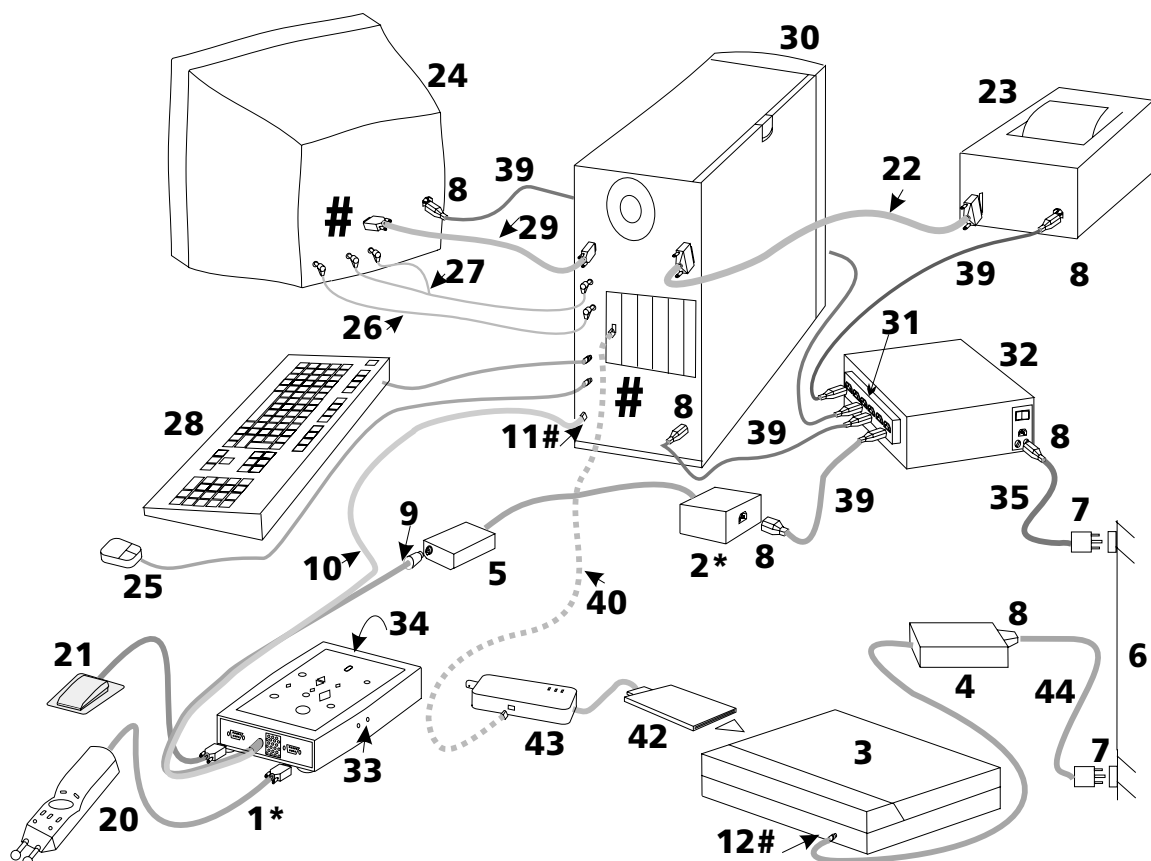
If Oxford Instruments Approved non-medical equipment supplied with the tower system were to be connected directly to a wall socket outlet then there may be a risk of the allowable leakage currents being exceeded.

Note that only PC cards and drives approved by Oxford Instruments Medical Ltd may be fitted into the PC tower.

Note The components of the Synergy Suite system may also be configured either as Notebook or Tower systems. Refer to previous sections 4.2.1 and 4.2.2.

For key to item number used please refer to Chapter 4 page 6 or 7

For Tower/Suite System step by step cable management on the trolley and connection diagrams see chapter 15



4.2.4 Caution and warnings

-  **Any internal operations on the equipment should only be undertaken by a suitably qualified technician.**
 -  **Do not connect any items to Synergy other than those specified for use with the system.**
 -  **U.S. Federal law restricts this device to sale by or on the order of a physician, or other licensed practitioner.**
 -  **Note that for the Synergy Systems the outlets of the Mains Isolating Transformer must only be used to power equipment approved by Oxford Instruments Medical Ltd. No other equipment may be powered from these outlets as there may be a risk of exceeding the power rating of the ISO800 Mains Isolating Transformer.**
 -  **Do not plug or unplug a stim probe or headbox with the power switched on or damage may result.**
 -  **When a system is in use, care must be taken to ensure a free flow of air around the units that make up the system. The flow of air from any vents or fans must not be obstructed.**
 -  **If any mains powered equipment, for example printers, video monitors or other medical equipment, is to be connected to Synergy to form a medical electrical system then the requirements of standard EN60601-1-1 (Medical Electrical Equipment, Part 1. General requirements for safety, Section 1.1 Collateral standard: Safety requirements for (medical electrical systems)) must be complied with to ensure patient and operator safety is maintained.**
 -  **Note that only PC cards and drives approved by Oxford Instruments Medical may be fitted into the Tower or Notebook PC. The fitting of unauthorised parts to the PC may compromise patient or operator safety.**
-  **Note: It is important that all applied parts are removed from the patient before operating the power switch or disconnecting any of the system's connection cables.**
 -  **Disposal of equipment**
When the equipment comes to the end of its operating life, it should be disposed of in accordance with local waste disposal regulations. Advice on this can usually be obtained from the local waste regulation authority which is typically within the local government office.
 -  **The Notebook PC contains several batteries. Any replacements must be of a type approved by the manufacturer of the notebook computer and are best replaced by an approved representative, of the PC manufacturer. *For further details consult the user manual for the Notebook PC.***
Note that failure to use the correct type of batteries may cause fire, explosion or other damage. The disposal of used batteries should be carried out as required by local ordinances and regulations.

4.3 Key to Numbers used on the PIU System connection Drawings

- 1 Patient Interface Unit (PIU)
- 2 Synergy Power Supply
- 3 Notebook PC
- 4 Notebook PC's Power Supply
- 5 Junction Box
- 6 Wall of Room
- 7 Separate Fixed Mains Socket Outlets
- 8 Mains Inlet
- 9 DC Power To PIU
- 10 USB Cable
- 11 To PC USB Port
- 12 DC Power To PC
- 14 Signal Cable
- 15 To Appropriate PC connector
- 17 Isolated mains
- 19 "Y" junction mains cable
- 20 Stimulator Probe (optional)
- 21 Footswitch (optional)
- 22 Signal to Printer
- 23 Oxford Instruments Approved Printer
- 24 Oxford Instruments Approved Monitor
- 25 Mouse
- 26 Microphone Signal
- 27 Audio Output Left and Right
- 28 Keyboard
- 29 SVGA signal to Monitor
- 30 Oxford Instruments Approved Tower PC

- 31 Isolated mains outlets
- 32 ISO-800 Isolation Transformer
- 33 Internal Stimulator Output connectors
- 34 Patient Recording Input connectors
- 35 IEC socket to Local mains connector(3 core 16AWG)
- 36 Suitable cable to connect Isolation Transformer to Other Non-Medical Equipment Class I
- 39 IEC Plug to IEC socket (connects Isolated mains)
- 40 Network direct connection – CAT5 shielded (STP) Patch Cable - Crossover (RJ45 connectors)
- 41 Alternative printer connection
- 42 Network card (PCMCIA-Ethernet)
- 43 Media coupler for network.
- 44 Notebooks own mains lead (local mains to Two pin outlet)

*This page 6 of chapter 4 is a **copy** of page 7 the A3 pullout key to the **PIU System drawings**. It is included for printing on A4 printers.*

1	Patient Interface Unit (PIU)	Tower PC
2	Synergy Power Supply	31 Isolated mains connection
3	Notebook PC	32 ISO-800 Isolation Transformer
4	Notebook PC's Power Supply	33 Internal Stimulator connectors
5	Junction Box	34 Patient Recording connectors
6	Wall of Room	35 IEC socket to Local connector(3 connections)
7	Separate Fixed Mains Socket Outlets	36 Suitable cable to connect Isolation Transformer Non-Medical Equipment
8	Mains Inlet	37 Suitable cable to connect Isolation Transformer Notebook PC Power Supply
9	DC Power To PIU	38 Suitable cable to connect mains connection Isolation Transformer
10	USB Cable	39 IEC Plug to IEC (connects Isolation Transformer)
11	To PC USB Port	40 Network direct connection CAT5 shielded (connects Isolation Transformer - Crossover connectors)
12	DC Power To PC	41 Alternative primary connection
13	Other Non-Medical Equipment (Class I Protectively Earthed)	42 Network card (PCMCIA-Ethernet)
14	Signal Cable	43 Media coupler
15	To Appropriate PC connector	44 Notebooks own connection (local mains to PC)
16	Isolation Transformer	
17	Isolated mains	
18	Other Non-Medical Equipment (Class I Double Insulated)	
19	"Y" junction mains cable	
20	Stimulator Probe (optional)	
21	Footswitch (optional)	
22	Signal to Printer	
23	Oxford Instruments Approved Printer	
24	Oxford Instruments Approved Monitor	

33	Internal Stimulator Output connectors	
34	Patient Recording Input connectors	
35	IEC socket to Local mains connector(3 core 16AWG)	
36	Suitable cable to connect Isolation Transformer to Other Non-Medical Equipment Class I	
39	IEC Plug to IEC socket (connects Isolated mains)	
40	Network direct connection – CAT5 shielded (STP) Patch Cable - Crossover (RJ45 connectors)	
41	Alternative printer connection	
42	Network card (PCMCIA-Ethernet)	
43	Media coupler for network.	
44	Notebooks own mains lead (local mains to Two pin outlet)	

4.4.1 Connection Diagram of Plinth System with Notebook

Multiple portable socket outlets must not be used.

#

Refer to notebook PC user manual to determine the position of the input/output connectors.

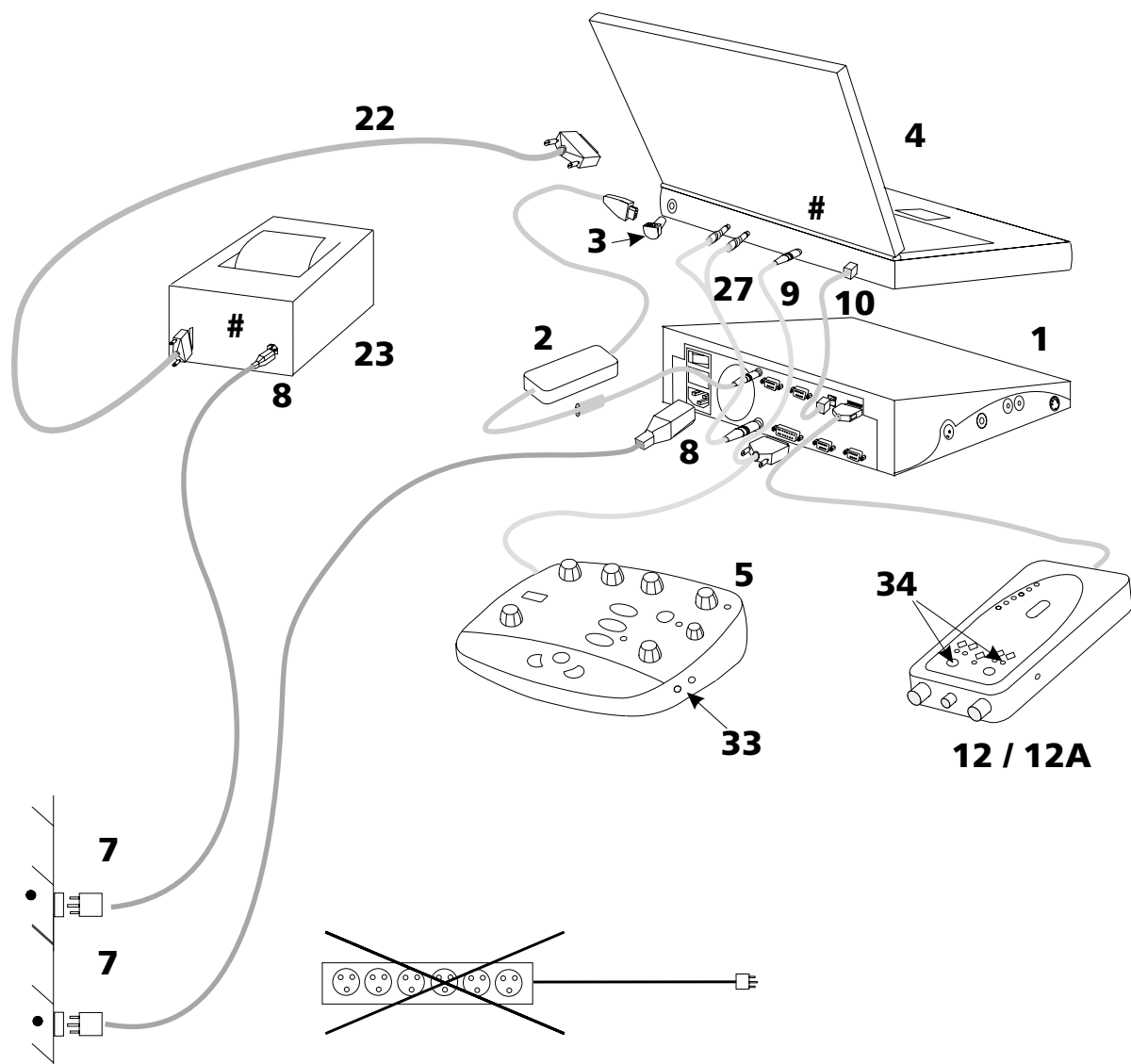
*

The Notebook PC must only be powered by the DC to DC "Universal Auto/Air™ Power Adaptor" (Supplies DC power from Plinth to Notebook). Part number CP310. The Notebook must not be powered for any other power supply.

Only the Oxford Instruments Approved Printer may be connected to this system

All parts of the synergy notebook System with Plinth shown in the diagram above may be used in the patient environment.

For key to item number used please refer to Chapter 4 page 12 or 13



4.4.3 Connections of Plinth System With Tower PC

Refer to Tower PC user manual to determine the position of the input/output connectors.

- Separate Fixed Mains Socket Outlets Must Be Used

The maximum permitted load for the ISB100W Mains Isolating Transformer is 1000VA.
The ISB100W Mains Isolating Transformer must not be placed on the floor.

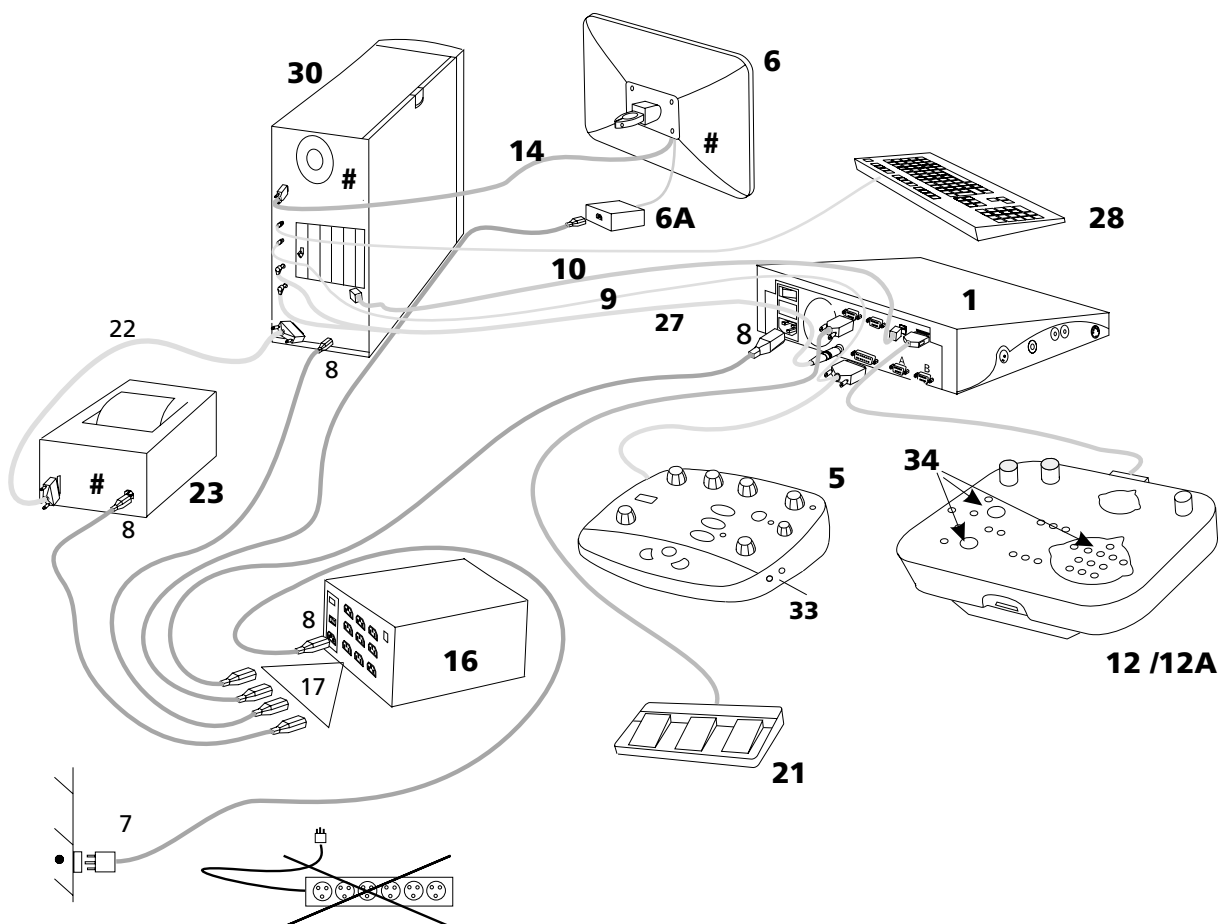
It should only be mounted on the cradle provided on the lower shelf of the system trolley.

The non-medical equipment supplied with the Synergy Tower system - the PC tower, the monitor and the optional printer must only be powered from the outlets of the ISB100W Mains Isolating Transformer.

If Oxford Instruments Approved non-medical equipment supplied with the tower system were to be connected directly to a wall socket outlet then there may be a risk of the allowable leakage currents being exceeded.

Note that only PC cards and drives approved by Oxford Instruments Medical Ltd may be fitted into the PC tower.

For key to item number used please refer to Chapter 4 page 12 or 13



Key to Numbers used on the **Plinth** System connection Drawings

This page 12 of chapter 4 is a **copy** of page 13 the A3 pullout key to the **Plinth System drawings**. It is included for printing on A4 printers.

- 1 Plinth
- 2 DC to DC "Universal Auto/Air™ Power Adaptor" (Supplies DC power from Plinth to Notebook)
- 3 Convertor for DC to DC "Universal Auto/Air™ Power Adaptor"
- 4 Oxford Instruments Approved Notebook PC
- 5 Control pannel and stimulator
- 6 Oxford Instruments Approved Flat panel monitor
- 6A Power supply for Flat panel monitor
- 7 Separate Fixed Mains Socket Outlets
- 8 Mains Inlet
- 9 Control Pannel to PC mouse connector for pointing device.
- 10 USB Cable
- 12 5 or 10 channel Amplifier
- 12A 2 channel Amplifier
- 14 Signal Cable to monitor
- 16 Isolation Transformer (must be used with Tower, optional with Notebook)
- 17 Isolated mains
- 20 Deluxe Stimulator Probe *
- 21 Tripple Footswitch *
- 21A Single Footswitch (IOM option)
- 22 Signal to Printer
- 23 Oxford Instruments Approved Printer *

- 25 Optional Mouse to PC (alternative to control panel pointing device) *
- 27 PC Connections Audio/Headphone Output (GREEN) also PC microphone input (PINK)
- 28 Keyboard
- 29 Oxford Instruments Approved Visual Stimulation Monitor *
- 29A Mains connection to Oxford Instruments Approved Visual Stimulation Monitor.(Refer to Advice on Installation)
- 29B Signal connection to Oxford Instruments Approved Visual Stimulation Monitor.
- 30 Oxford Instruments Approved Tower PC
- 33 Control Panel Stimulator Output connectors
- 34 Patient Recording Input connectors
- 43 Temperature probe * (connection points marked "T")
- 44 Patient Headphones for AEP tests *
- 45 Microphone (Doctor/patient EP tests)*
- 50 IOM stimulator *
- 51 Patient side headbox *
- 52 I/O Interface box *
- 53 LED goggles *
- 54 Stimulus probe head adjustable 45° angle or straight *
- 55 Stimulus probe head fixed 45° angle *
- 56 Stimulus probe head fixed straight *
- 62 Patient responce unit *

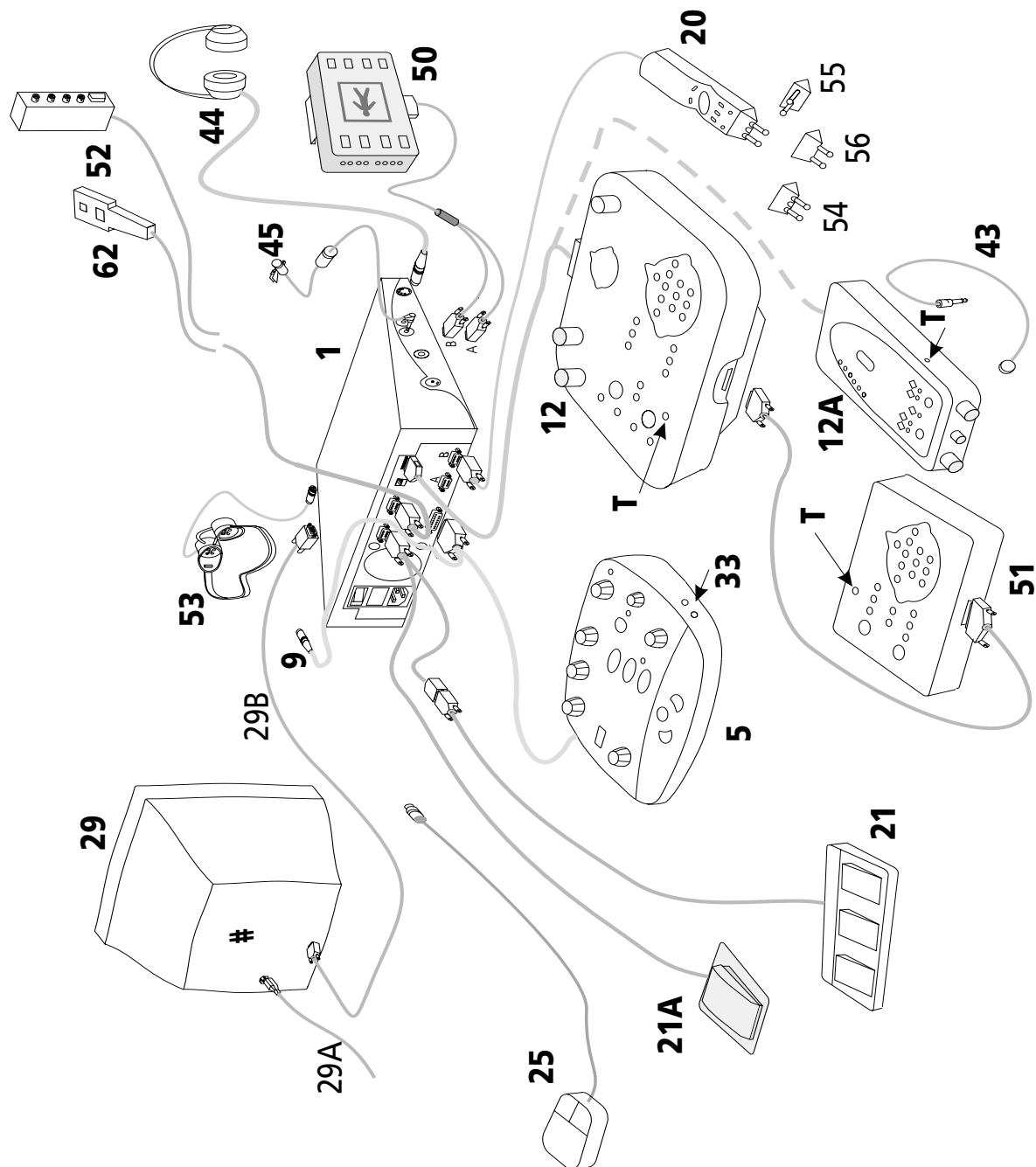
***=Optional**

= Refer to maufacturers information for connections

connection Drawings		28	Keyboard
1	Plinth	29	Oxford Instruments Visual Stimulation
2	DC to DC "Universal Auto/Air™ Power Adaptor" (Supplies DC power from Plinth to Notebook	29A	Mains connection Instruments Approved Stimulation Monitor on Installation)
3	Convertor for DC to DC "Universal Auto/Air™ Power Adaptor"	29B	Signal connection Instruments Approved Stimulation Monitor
4	Oxford Instruments Approved Notebook PC	30	Oxford Instruments Tower PC
5	Control pannel and stimulator	33	Control Panel Stimulators connectors
6	Oxford Instruments Approved Flat panel monitor	34	Patient Recording
6A	Power supply for Flat panel monitor	43	Temperature probe points marked "T"
7	Separate Fixed Mains Socket Outlets	44	Patient Headphone
8	Mains Inlet	45	Microphone (Doctor)
9	Control Pannel to PC mouse connector for pointing device.	50	IOM stimulator *
10	USB Cable	51	Patient side headbox
12	5 or 10 channel Amplifier	52	I/O Interface box *
12A	2 channel Amplifier	53	LED goggles *
14	Signal Cable to monitor	54	Stimulus probe head angle or straight *
16	Isolation Transformer (must be used with Tower, optional with Notebook)	55	Stimulus probe head
17	Isolated mains	56	Stimulus probe head
20	Deluxe Stimulator Probe *	62	Patient response unit
21	Tripple Footswitch *	* =Optional	
21A	Single Footswitch (IOM option)	# = Refer to main information for connection	
22	Signal to Printer		
23	Oxford Instruments Approved Printer *		

28	Keyboard	
29	Oxford Instruments Approved Visual Stimulation Monitor *	
29A	Mains connection to Oxford Instruments Approved Visual Stimulation Monitor.(Refer to Advice on Installation)	
29B	Signal connection to Oxford Instruments Approved Visual Stimulation Monitor.	
30	Oxford Instruments Approved Tower PC	
33	Control Panel Stimulator Output connectors	
34	Patient Recording Input connectors	
43	Temperature probe * (connection points marked "T")	
44	Patient Headphones for AEP tests *	
45	Microphone (Doctor/patient EP tests)*	
50	IOM stimulator *	
51	Patient side headbox *	
52	I/O Interface box *	
53	LED goggles *	
54	Stimulus probe head adjustable 45° angle or straight *	
55	Stimulus probe head fixed 45° angle *	
56	Stimulus probe head fixed straight *	
62	Patient response unit *	
	*=Optional	
	# = Refer to manufacturers information for connections	

4.5.1 Connection of Accessories Available for Plinth System



For key to item number used please refer to Chapter 4 page 12 or 13

4.6 Symbols

Certain important functions are identified by the following pictographs.

Note: Not all the symbols may be used on any particular systems. Also symbols will not appear on your unit if the warning or function is written in full in your own language

4.6.1 WARNING SYMBOLS



Alternating Current (ac)

CAUTION: TO REDUCE THE RISK OF ELECTRIC SHOCK DO NOT REMOVE COVER. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.



BEFORE CONNECTING REFER TO THE APPROPRIATE PAGES IN THE MANUAL.



CAUTION: DO NOT OBSTRUCT COOLING VENTS.



NO USER SERVICEABLE PARTS INSIDE.

REFER TO CAUTIONS AND WARNINGS ON THE USE OF STIMULATORS. (In the User Manual)



BEFORE CONNECTING ENSURE THAT MAINS VOLTAGES AND FUSES RATINGS ARE CORRECT.



THE PATIENT INTERFACE UNIT MUST ONLY BE POWERED FROM THE SYNERGY POWER SUPPLY - 035C005



WARNING THAT THE UNIT CONTAINS HIGH VOLTAGE PARTS



TYPE BF. THE SYMBOL FOR TYPE BF EQUIPMENT WITH ISOLATED APPLIED PARTS.

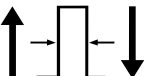
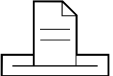


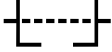
RISK OF EXPLOSION- DO NOT USE IN THE PRESENCE OF EXPLOSIVE ANAESTHETICS.

4.6.2 INFORMATION SYMBOLS



Preamplifier

	Direct current (dc)
	Amplifier Off
	Amplifier On
	Stimulus
	Stimulus duration
	Stimulus duration increase/decrease
	Stimulus repetition rate
	Trigger - rising edge
	Trigger - falling edge
	Double headed arrow = Acquire (continuous) Single headed arrow = Acquire (momentary)
	Rotate clockwise to increase
	Isolating transformer
	Equipotential earth terminal
	Audio Volume
	Output
	Input
	External printer interface
	Footswitch

	Universal serial bus (USB)
	Communication port
	External monitor
	Temperature probe
	Deluxe Stimulator Probe
	Patient ground
	Function
	Next
	Erase
	Acquire

4.6.3 Plinth Information Symbols



Off



On



Mains Lead connector



Connection to "Universal
Auto/Air™ PowerAdaptor"
(Supplies DC power from
Plinth to Notebook)



PC

Connection to PC Audio
(Yellow)



Connection to Footswitch
(Orange)



Connection to Control
Panel Interface (Brown)



External Trigger
Port



Universal serial bus (USB)



Connections for 2 Deluxe
Stimulator Probes A & B



Amplifier Interface (Black)



EMG

connection to External
EMG Speaker



EMG

Connection to External
EMG headphones



EP

Mircophone Input for
Auditory EP



EP

Auxiliary Input for
Auditory EP



EP

Headphones for Auditory
EP



Visual EP LED Goggles
interface



Visual EP Monitor
interface

4.7 Signal Cables

High quality screened cables must be used when connecting to the auxiliary input/output connectors of Synergy Systems to ensure compliance with EMC regulations. Braid screened or double screened (braid plus foil) cables are the preferred types. The cable screen should make a 360° connection to the screening shells of the connectors on each end of the cable.

4.8 Installation

4.8.1 Inspection all systems

Check that there are no obvious defects or damage to the Tower PC or the Notebook PC.

Check Patient Interface Unit, Plinth, Control Panel Stimulus Probe, any other purchased options and any other cables or accessories.

In the case of the Notebook system check the Notebook PC Power supply and the Oxford Instruments Synergy medical grade Power Supply.

In the case of the Notebook Plinth system check the dc to dc "Universal Auto/Air™ Power Adaptor". This must be used to power the Notebook PC from the Plinth.

4.9 Notebook PIU System Mains Supply Cables and connections

Check the supplied "Y" Junction Mains cable. One outlet of this "Y" mains supply cable is fitted with a shrouded 3-pin mains connector (female) which mates with the inlet of the Synergy medical grade Power Supply.

The other outlet of this "Y" mains supply cable is fitted with a shrouded 2-pin mains connector (female) which mates with the inlet of the Notebooks PC power supply.

Check that the free inlet end of the "Y" mains supply cable is fitted with a suitably rated mains plug having protective earth connection. The wires are colour coded as follows:

Brown = Line
Blue = Neutral
Green/Yellow = Protective Earth

It is essential that the protective earth conductor is connected to an external protective earth system to ensure patient safety and correct operation of the unit. This protection is automatic in three-wire mains systems if the mains plug has been correctly wired.

When a mains plug is designed to hold a fuse fit a 3A rated fuse for the Synergy Notebook system.

4.9.1 Notebook PIU System Voltage selection

There are no mains selector switches for local mains voltage on the **Synergy medical grade power supply** (035C005). The supply will operate on any voltage in the range 100V-240Vac 50-60Hz. Its maximum current consumption is 1A.

The output of the supply is rated at 15V DC 3.3A.

Check the mains input voltage requirements of the **PC's Power Supply** in the Notebook PC's User Manual. Typically they will operate on any voltage in the range 100V-240V ac 50-60Hz. The current drawn will be around 1A at 100V and 0.5A at 230V.

If any fuse fails shortly after replacement, a fault is indicated and a qualified electronic technician should be consulted to trace and repair the fault.

4.10 Tower PIU System Mains Supply Cables and connections

Check the supplied mains cable. The equipment end of this mains supply cable is fitted with a shrouded 3-pin mains connector (female) which mates with the inlet of the **ISO800 Isolating Transformer**. Check that the outlet end of the mains supply cable is fitted with a suitably rated mains plug having protective earth connection. The wires are colour coded as follows:

Brown = Line
Blue = Neutral
Green/Yellow = Protective Earth

It is essential that the protective earth conductor is connected to an external protective earth system to ensure patient safety and correct operation of the unit. This protection is automatic in three-wire mains systems if the mains plug has been correctly wired.

When a mains plug is designed to hold a fuse fit a 7A rated fuse for the Synergy Tower system.

4.10.1 Tower PIU System Voltage selection

All parts of the tower System must be powered from the outlets of the **ISO800 Isolating transformer**.

Before switching on check the following:-

- ♦ That the ISO800 is marked with the correct voltage for your local supply.

The ISO800 is factory set to either

230V input / 230V output

Or

115V input / 115V output

- ♦ That the input voltages of the **PC Tower, the monitor** and the optional **printer** are all set to match the output voltage of the ISO800. Refer rating labels and user manuals of these pieces of equipment to check if adjustments is necessary and for information on how to carry out any required adjustments.

Rated input voltage of the ISO800:
115V/230V

Rated Supply frequency:50/60Hz

Maximum Peak Power Consumption: 840VA

The ISO800 Isolating Transformer has inlet fuses in both the Line and Neutral. These two fuses, F3 and F4, are situated between the mains inlet and the on/off switch.

Fuses for the ISO800 Insulating Transformer

Mains Voltage	F3 and F4
115V	T10A L250V
230V	T6.3A L250V

The Tower PIU system will also include the Synergy medical grade power supply which requires no mains adjustment for local mains voltage. The supply will operate on any voltage in the range 100V-240V 50-60Hz. Its maximum current consumption is 1A.

The output of the supply is rated at 15V DC 3.3A.

4.11 Connecting PIU Systems

Follow the appropriate connection diagram for either Tower or Notebook PIU System

If any fuse fails shortly after replacement, a fault is indicated and a qualified electronic technician should be consulted to trace and repair the fault.

4.12 Suite PIU Systems Mains Supply Cables and connections

As the Synergy PIU Suite System is essentially a combination of components from both the Synergy PIU Notebook and the Synergy PIU Tower system.

Please refer to the two previous sections 4.8 to 4.10 for checking the mains supply cable, supply voltage settings Fuses and connection diagrams.

If any fuse fails shortly after replacement, a fault is indicated and a qualified electronic technician should be consulted to trace and repair the fault.

4.13 Installing Plinth Systems.

4.13.1 Installing Isolating Transformer ISB100W for Plinth Tower Systems.

All parts of the Tower Plinth System **must** be powered from the outlets of the Isolating Transformer.

This is an option with Notebook Plinth systems.

Before switching on check the following:-

- ♦ That the ISB100W is set for your local supply voltage.

The ISB100W is factory set to either

230V input / 230V output

Or

115V input / 115V output

The **input voltage** setting is displayed in the window in the flap above the transformers on/off switch.

The **Output voltage** setting can be seen by looking at the position of the red switch on the back of the transformer.

Up is 115V output and down is 230V output.

If required because you are moving the system to an area with a different mains voltage. The input voltage can be altered by opening the flap above the on/off switch, removing the red fuse holder, turning it over then refitting.

The output voltage can be altered by changing the position of the red switch on the back of the transformer.

- ♦ That the input voltages of the **PC**, the **monitor** and the optional **printer** are all set to match the local mains voltage and the output voltage of the ISB100W.

Refer to the rating labels and user manuals of these pieces of equipment to check if adjustments is necessary and for information on how to carry out any required adjustments.

The **ISB-100W** is manufactured by the Toroid Corp of Maryland.

Rated input voltage of the ISB100W: 115V/230V.

Rated Supply frequency:50/60Hz

Maximum Peak Power Consumption: 1000VA

Fusing of ISB100W Isolating Transformer

The Mains inlet incorporate two fuses one in the Line and one in the neutrel to guard against catastrophic failure. Both fuses must be European and UL/CSA approval

Mains inlet Voltage	ISB100W FUSE RATING
115V	T10A AT
230V	T5A AT

4.14 Mains Inlet to Plinth

4.14.1 Fusing of Plinth

The Mains inlet incorporate two fuses one in the Line and one in the neutral to guard against catastrophic failure. Both fuses must be European and UL/CSA approval

FUSE NUMBER	FUSE RATING
	100 - 240V
F1/F2 Mains inlet	T3.15A L250V

4.15 Connecting Plinth Systems

Follow the appropriate connection diagram for either Tower or Notebook Plinth System.

If any fuse fails shortly after replacement, a fault is indicated and a qualified electronic technician should be consulted to trace and repair the fault.

4.16 Brief Description of parts

4.16.1 The Patient Interface Unit

The Patient Interface Unit has a captive lead which splits into two cables at its remote end. One end connects to the USB port on the PC, the other to the junction box which is already connected to the medical grade Power Supply assembly. The Patient Interface Unit

4.16.2 The Plinth Unit

The **Plinth unit** acts as an interface from the PC to the separate 5 or 10 channel Synergy Amplifiers. The link with the PC is via the cable to the USB port.

In addition to the plinth, a small **control panel**, which contains a Control Panel pointing device and the Control Panel EMG electrical stimulator.

The Plinth also has the option features of **visual** and **auditory EP** Stimuli.

The Plinth Unit contains a medical grade Power Supply assembly.

4.16.3 Foot switch

The Foot switch has a 9 Way D type plug which connects to a socket marked  on the PIU or Plinth.

4.16.4 Deluxe Stimulator Probe (optional)

The Deluxe Stimulator Probe has a 9 Way D type plug which connects to a socket marked  on the PIU or Plinth.

4.16.5 Printer (optional)

The data lead from the printer must be connected to the socket marked . This is a 25 way D - type socket on the rear of the PC. See warnings on the Connection of Other Non-medical Equipment.

4.16.6 Mouse

If a optional mouse is to be used with the PC a PS/2 type will be required fitted with a 6 pin mini-DIN connector. This should be connected to the socket on the PS/2 port marked  on the rear panel of the PC.

4.17 Routine Maintenance

 **ON NO ACCOUNT SHOULD THIS EQUIPMENT BE AUTOCLAVED OR STERILISED BY EXPOSURE TO HEAT, RADIATION OR ANY FLUID.**

4.17.1 Cleaning the Systems and trolley.

The covers and any plastic mouldings may be wiped clean with a dry, lint-free cloth, blown free of dust with a low-pressure airline or carefully cleaned with a suitable vacuum cleaner. Stubborn greasy dirt on the case and panels may be wiped off using a damp cloth moistened with a little mild detergent (washing-up liquid). On no account should any liquid be allowed to enter the case.

The System uses solid state components and little routine maintenance is required.

If a fuse should fail, see relevant subsection. If the fuse fails again indicating a fault condition,

You should consult:

The appointed *Oxford Instruments Medical Ltd* subsidiary or distributor in your country. See the contact information at the front of this manual.

4.18 Controls on the Patient Interface Unit

To simplify operation, the number of controls has been minimised.

The functions of these controls is listed below.

VOLUME	This rotary control adjusts the volume of the audio output from the notebook internal loudspeakers or from the external speakers if connected to the notebook.	ERASE	Pressing this button erases the selected trace(s) but may depend on the system mode. Results associated with the trace(s) will also be erased. Press this switch to erase the selected trace or traces. This enables you to collect a fresh set of data in the same store.
FUNCTION Fn	The function of this front panel rotary control depends on the selection made under Display, Test Options. If Trigger is selected the control will adjust the vertical position of the trigger point. The push-button on the shaft acts as a "Trigger On/Off" control. If Marker is selected the control will adjust the placing a marker. The push-button on the shaft selects each marker in turn. If Cursor is selected the control will adjust the position of the cursor. The push-button on the shaft selects each cursor in turn.	STIMULUS DURATION	This rotary switch is used to increment or decrement the duration (pulse width) of the EMG stimulus.
TRIGGER POLARITY +/- SWITCH	This push button control selects whether the signal is being triggered on the positive or negative going edge. This switch is only useable in Signal Trigger mode.	STIMULUS INTENSITY	This rotary control is used to set the intensity of the electrical stimulus pulse for the internal EMG stimulator.
SENSITIVITY	This rotary control adjusts the Display Sensitivity of the selected trace(s).	STIM	Pressing this button turns the stimulus on, without acquiring patient data.
SWEEP DURATION	This rotary control adjusts the Sweep Duration of the selected channel(s).	NEXT	Pressing this button, retains the current data, and selects the next store(s) ready for data acquisition. Use to move to the Next site in NCV or EMG tests.
ACQUIRE ON SWITCH	Pressing this switch sets acquire "ON". Pressing again will turn acquire "OFF"	AMPLIFIER ON /OFF & CALIBRATE SIGNAL	In the on position this slider switch selects the amplifier input sockets on the end panel, in the off position these inputs are grounded. With the switch in the off position the CAL signal may be switched to the amplifier inputs. This is controlled from the GUI.
ACQUIRE SINGLE SWITCH	Press this briefly once to deliver a stimulus and acquire a response. Pressing and holding the switch for more than one second will lock acquisition "ON". If acquire is already latched on, pressing either switch will turn acquire off. This control operates in parallel with acquire on the optional stimulator probe.		

4.18.1 Stim Probe

The optional Deluxe Stimulator Probe enables you to control the following:

Stim ON / OFF	Press this switch to deliver a stimulus without acquiring data. This switch turns the stimulus ON and OFF. If all stimuli are OFF when you press the switch, stimulus is set ON. If Acquire is ON, pressing this switch has no effect.
Next switch	This switch is used only in NCV tests. Press it to move to the next site.
Stimulus Polarity	Press this control to change the polarity of the stimulus: the positive probe tip changes to negative and the negative probe tip changes to positive. Note that the positive probe tip has its LED lit.
Stim Intensity/Acquire	Rotate this control to adjust the amplitude of the stimulus. Stim Intensity is displayed in the Toolbar. Briefly push in this rotary switch to deliver the stimulus and acquire the data. Hold in for more than 1 second to latch stimulus and acquire on. Press briefly to turn stimulus and acquire off.
Stim Duration Up / Down	Press the up or down button to increase or decrease the duration (pulse width) of the stimulus.

4.18.2 Control Panel Functions (used with Plinth Systems)

Fn1	Programmable via the Display menu to control Marker, Trigger or Cursor.
Fn2	Programmable via the Display menu to control Averager On/Off, record cursor, trigger polarity, EMG Staging.
Volume	Rotate to change the level of the audio output of the input signal. Set it to zero for no audio output.
Sensitivity	Rotate to adjust the display sensitivity of the selected trace or traces. If no trace is selected (to deselect a trace click away from it), the sensitivity of all the traces in the current test is changed.
Next	Push to move to the next site in NCS and EMG tests.
Sweep Duration	Rotate to adjust the acquisition sweep duration for the active trace(s). Once data has been acquired you can also increase or decrease the sweep duration for selected traces.
Erase	Push to erase the selected trace or traces. This enables you to collect a fresh set of data in the same store.
Acquire ON/OFF	Push to set acquire ON. Press it again to set Acquire OFF.
Acquire Single	Push to set acquire ON. Press it again to set Acquire OFF.
Stim B	Push once to deliver a stimulus and acquire a response. If you hold down this button for more than 1 second, Acquisition is locked on. Push again to stop Acquisition.
Green light	Indicates the control panel has power.
Stim On/Off	Push to toggle Stimulus On and Off, without acquiring. If Acquire is On, pushing this button has no affect.
Stim Duration	Rotate to adjust the duration (pulse width) of the stimulus.
Stim A	Rotate to adjust the amplitude of the internal stimulus. Stim Intensity is displayed on the tool bar and also on the Status Panel.
Right button	Push to open a menu
Pointing device	Push to move pointer on screen.
Left button	Push to select
On rear of control panel	Removable clip for attachment of the control panel to a bedside, blanket, desk, keyboard on mouse tray of the trolley

4.19 Notebook and Tower PC Connections

There are several connectors on the PC but generally only a few will be used. The position of these may vary with different models of PC. However the pinouts are fairly standard (Check with your PC's documentation to confirm pinouts).

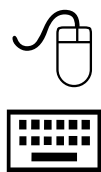
Peripheral equipment not supplied by Oxford Instruments should not be Connected.

4.19.1 Connections on the current PCs.

 PC Video Output 15 way D Density & half socket	
Pin No.	Service
1	Red video
2	Green video
3	Blue video
4	N/C
5	Self Test
6	Red signal return
7	Green signal return
8	Blue signal return
9	N/C
10	Digital ground
11	Digital ground
12	DDC Data
13	Horizontal Sync.
14	Vertical Sync.
15	DDC Clock

 PC Printer Port 25 way D type socket	
Pin No.	Service
1	Strobe
2	Data 0
3	Data 1
4	Data 2
5	Data 3
6	Data 4
7	Data 5
8	Data 6
9	Data 7
10	Acknowledge
11	Busy
12	P.E.
13	Select
14	Autofeed
15	Error
16	Init.
17	Select In
18 – 25	Ground

 PC Serial Port 9 way D-type plug	
Pin No.	Service
1	DCD Carrier Detect
2	RxD Receive Data
3	TxD Transmit Data
4	DTR Data Terminal Ready
5	GND Signal Ground
6	DSR Data Set Ready
7	RTS Request to Send
8	CTS Clear to Send
9	RI Ring Indicator



**PC PS/2 Mouse/Keyboard
Port**
6 pin Mini DIN socket

Pin No.	Service
1	Data+
2,6	Reserved
3	Ground
4	+5V d.c.
5	Data clock +
Shield	Frame ground



**Universal Serial Bus
(downstream Port)**

Pin No.	Service
1	VCC
2	- Data
3	+ Data
4	Ground



External Headphone Jack
Note 16 Ohms minimum
3.5mm jack socket

Section	Audio signal
Sleeve	Signal Ground
Ring	Left
Tip	Right



Mono Microphone Jack
3.5mm jack socket

Section	Audio signal
Sleeve	Signal Ground
Tip	Signal

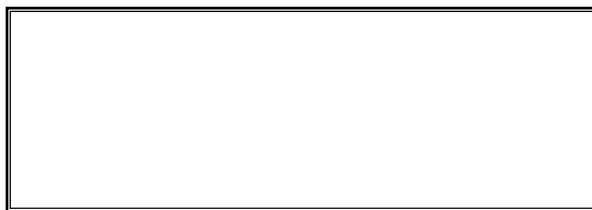


Figure 4-5 Headbox connector viewed from outside of mainframe



Stereo Line in Jack
3.5mm jack socket

Section	Audio signal
Sleeve	Signal Ground
Ring	Left
Tip	Right

4.19.2 Network Cards and connections

PCMCIA network card + Pod (optional for Notebook and standard in Suite)

PCI network card for Tower (optional for Tower and standard in Suite)

For Notebook the network connectors will be in a pod which is connected to the PCMCIA card by a short lead.

These connections are typical of standard cards available.

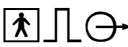
Network Card	Ethernet BNC Socket
Pin No.	Service
Inner	Signal
Outer	Screen

Network Card 	RJ-45 8/8 data socket
Pin No.	Service
1	TD+
2	TD-
3	RD+
6	RD-
4,5,7,8	N/C

4.20 Connections on Patient Interface Unit

	Footswitch 9 way D type socket
Pin No.	Service
1	N/C
2	N/C
3	Acquire
4	N/C
5	0V (Footswitch)
6	N/C
7	N/C
8	N/C
9	N/C

	EMG Stimulator Probe 9 way D type socket
Pin No.	Service
1	+12V
2	RS232 to Stim
3	RS232 from Stim
4	EMG positive trigger
5	0V
6	0V
7	EMG negative trigger
8	Stim OK
9	Sync

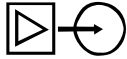
	PIU EMG Internal Stimulator 2 x Touchproof Connectors
Red	Stim +
Black	Stim -

4.20.1 Amplifier Inputs on PIU

	Amplifier Inputs 5 x Touchproof Connectors
Red	Channel 1+
Black	Channel 1-
Green	Neutral 
Black	Channel 2-
Red	Channel 2+

4.20.2 Temperature Probe Input

	Temperature Probe Input 3.5 mm Jack Socket
Tip	Thermistor Hi
Sleeve	Thermistor Lo



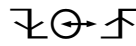
Headbox Connector
26 pin High Density

Pin No.	Service
1	0V
2	N/C
3	-12V
4	-12V
5	RS232_TO_HB
6	HBDATA-D
7	HBCLOCK-D
8	HBFRAME-D
9	N/C
10	N/C
11	+12V
12	N/C
13	0V
14	0V
15	N/C
16	+12V
17	+12V
18	RS232_FROM_HB
19	/HBDATA-D
20	/HBCLOCK-D
21	/HBFRAME-D
22	/HBOX_OK
23	N/C
24	-12V
25	N/C
26	0V

4.21 Plinth Connections

 Control Panel 15 way D type socket	
Pin No.	Service
1	PSU_SYCN
2	RS232 From panel
3	EMG+ trig
4	Clock PS2
5	+12V Stim
6	+5V PS2
7	
8	Mic 0V
9	RS232 TO panel
10	EMG- trig
11	Data PS2
12	0V stim
13	
14	0V PS2
15	Mic signal

 Footswitch 9 way D type socket	
Pin No.	Service
1	N/C
2	N/C
3	Acquire
4	Accept
5	0V (Footswitch)
6	N/C
7	Program
8	N/C
9	N/C

 Patient Digital I/O 9 way D type socket	
Pin No.	Service
1	Patient Data
2	+24V
3	N/C
4	0V (24V return)
5	0V (24V return)
6	External Trigger 1 (Input)
7	External Trigger 2 (Input)
8	External Trigger 1 (Output)
9	External Trigger 2 (Output)

 EMG Probes (Stim A Stim and B) 9 way D type socket	
Pin No.	Service
1	+12V
2	RS232 to STIM
3	RS232 from STIM
4	EMG positive trigger
5	0V
6	0V
7	EMG negative trigger
8	Stim OK
9	Sync


**EMG Probe (Stim B)
9 way D type socket**

Pin No.	Service
1	+12V
2	RS232 to STIM
3	RS232 from STIM
4	EMG positive trigger
5	0V
6	0V
7	EMG negative trigger
8	Stim OK
9	Sync

**4.21.1 Plinth Connections EP Stimulator
(Optional)**

**Audio Transducer
5 way 180° DIN socket**

Pin No.	Service
1	Right Ear Signal
2	N/C
3	Right Ear Return
4	Left Ear Return
5	Left Ear Signal


**EP Auxiliary I/O
Connector
8-way DIN socket**

Pin No.	Service
1	Right LED driver
2	T2 Out Signal
3	R2 IN Signal
4	Left LED driver
5	N/C
6	+5V
7	+24V
8	0V (Shell)


**Microphone Input
2.5mm stereo jack
socket**

Pin	Service
Tip	EP Microphone signal input
Ring	N/C
Screen	Signal ground


**External Input
2.5mm stereo jack
socket**

Pin	Service
Tip	Ext EP Audio signal input
Ring	Ext EP Audio Noise input
Screen	Signal ground


**EP Video Stimulator
15 way D sub+half
socket**

Pin No.	Service
1	Red video signal output
2	Green video signal output
3	Blue video signal output
5 – 8	Signal ground
9	N/C
10	Signal ground
11	N/C
12	N/C
13	Horizontal sync.
14	Vertical sync.
15	N/C

4.21.2 Peripheral Connectors

The following tables show pin-outs of connectors on peripheral devices e.g. headbox.

Headbox Connector 26 pin High Density (see)	
Pin No.	Service
1	0V
2	N/C
3	-12V
4	-12V
5	RS232_TO_HB
6	HBDATA-D
7	HBCLOCK-D
8	HBFRAME-D
9	N/C
10	N/C
11	+12V
12	N/C
13	0V
14	0V
15	N/C
16	+12V
17	+12V
18	RS232_FROM_HB
19	/HBDATA-D
20	/HBCLOCK-D
21	/HBFRAME-D
22	0V
23	N/C
24	-12V
25	N/C
26	0V

Remote Jackbox Connector 25 pin D-type Socket	
Pin No.	Service
1	24k pull-up to +5V for temperature probe input
2	X2
3	EMG1+
4	X1
5	X4
6	X6
7	Screen drive
8	T5
9	Fz
10	Pz
11	C4
12	O2
13	A2
14	0VAI (for temperature probe input)
15	Neutral
16	EMG1-
17	X3
18	X5
19	A1
20	C3
21	O1
22	Cz
23	Oz
24	T6
25	N/C

4.21.2 Peripheral Connectors

The following tables show pin-outs of connectors on peripheral devices e.g. headbox.

Headbox Connector 26 pin High Density (see)	
Pin No.	Service
1	0V
2	N/C
3	-12V
4	-12V
5	RS232_TO_HB
6	HBDATA-D
7	HBCLOCK-D
8	HBFRAME-D
9	N/C
10	N/C
11	+12V
12	N/C
13	0V
14	0V
15	N/C
16	+12V
17	+12V
18	RS232_FROM_HB
19	/HBDATA-D
20	/HBCLOCK-D
21	/HBFRAME-D
22	0V
23	N/C
24	-12V
25	N/C
26	0V

Remote Jackbox Connector 25 pin D-type Socket	
Pin No.	Service
1	24k pull-up to +5V for temperature probe input
2	X2
3	EMG1+
4	X1
5	X4
6	X6
7	Screen drive
8	T5
9	Fz
10	Pz
11	C4
12	O2
13	A2
14	0VAI (for temperature probe input)
15	Neutral
16	EMG1-
17	X3
18	X5
19	A1
20	C3
21	O1
22	Cz
23	Oz
24	T6
25	N/C

TECHNICAL OVERVIEW PIU SYSTEM

5.1 Outline and scope of overview

This section covers the following areas:-

A description of the Synergy Systems with **PIU** which are multitasking PC based systems controlled by a Pentium processor in either a tower PC or a notebook PC

A description of the Patient Interface Unit ((**PIU**)) which is connected to the PC via the USB connector. The Patient Interface Unit contains the Patient Amplifiers and the internal Electrical Stimulator. There is an option to use an external hand held stimulator probe.

An overall schematic diagram of the systems is shown in Figure 5.1 and 5.2. The main differences between the systems is the way in which they must be powered. Note the use of the Isolating Transformer and the Medical grade power supply

Further block diagrams and simplified descriptions of functional sections are provided in this chapter to aid understanding.

This does not imply that there are distributor or user replaceable parts within these sections (due to the SMT components used).

5.2 The PC

The processor speed and the specification of the PC for a particular system will depend on the model of PC available at the time the system was purchased.

The minimum PC memory installed is 64MByte, additional HP approved compatible memory can be installed if required.

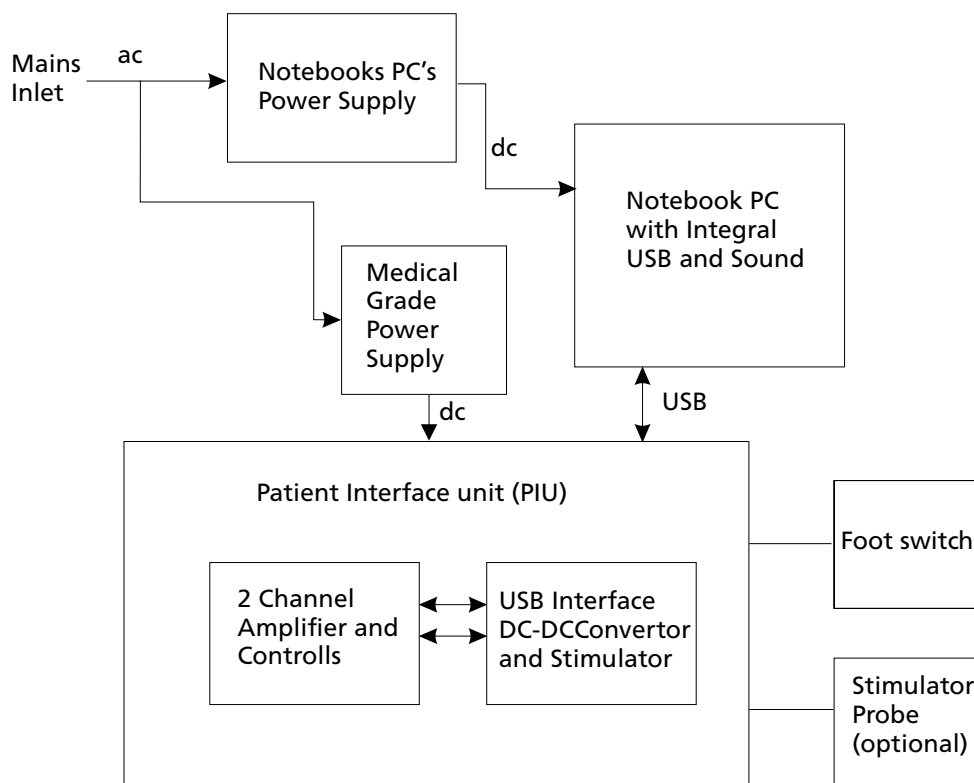


Figure 5.1 Notebook System block diagram

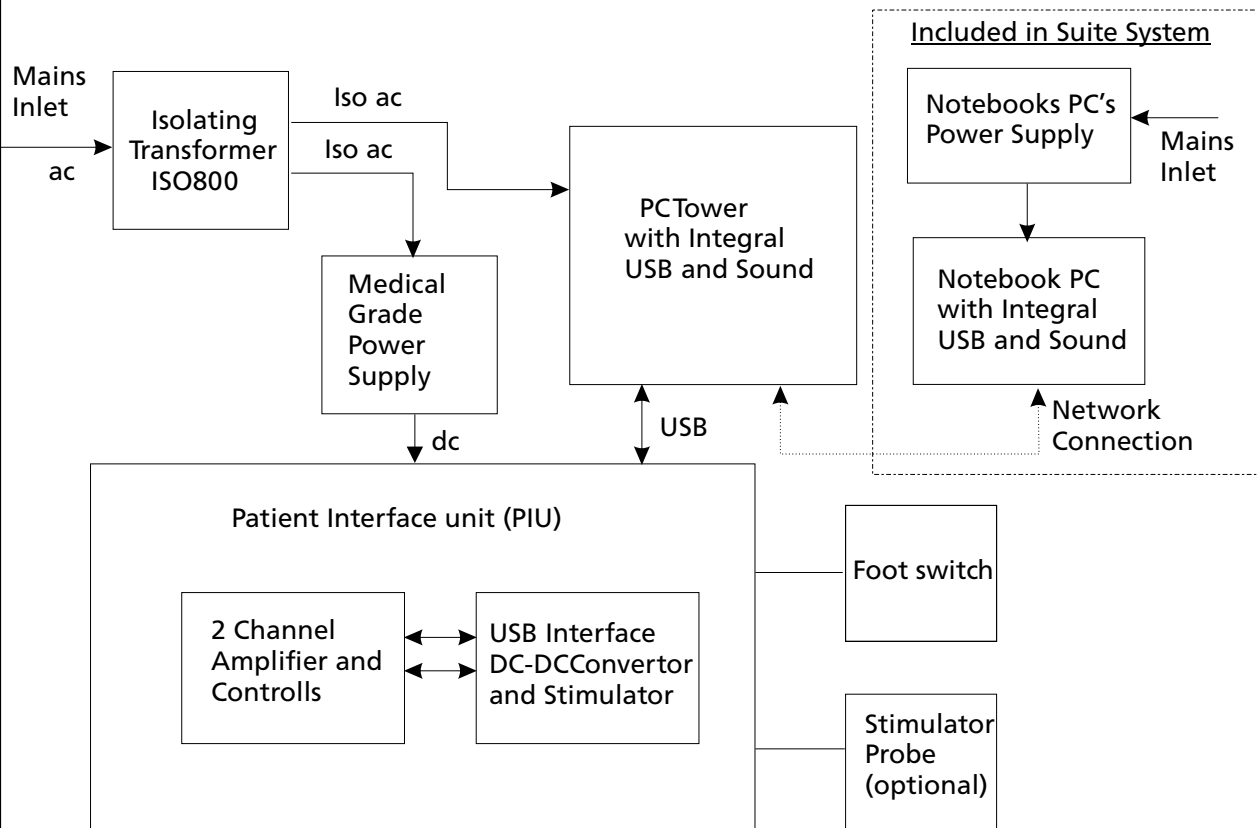


Figure 5.2 Tower / Suite System block diagram

In all systems Primary and secondary enhanced IDE controllers are built into the PC these are used for the hard disk and CD-ROM drive. There is a separate controller for the floppy disk drive. In the **Notebook**, PC card Slots (PCMCIA) can be used for optional expansion of the PC's functions. There is space for two 5mm Type 2 cards or one 10.5mm Type 3 card. The slots support 16 bit PC cards including PC card 16's and Cardbus PC cards. Cardbus supports the new standard 32bit standard PC cards. There is an Infrared port (IrDA 1.1) for cableless data transfer. There is one enhanced serial port, one enhanced parallel port and one PS/2 connector for the mouse / keyboard. *Note* Only optional cards approved by Oxford Instruments Medical Ltd may be used.

5.3 The Patient Interface Unit

5.3.1 Introduction to PIU

The patient responses are recorded via the electronics contained in the Synergy Systems Patient Interface Unit. This description includes sections dealing with the amplification and digitisation of the patient signals, the internal stimulator and the interface to the PC by means of the Universal Serial Bus (USB).

The method of electrical isolation and power distribution between these sections is crucial to maintaining patient safety.

Figure 5.1 shows an overall system block diagram.

Definitions

Universal Serial Bus. As defined in the document "Universal Serial Bus Specification" Revision 1 dated 15th January 1996 by Compaq, Digital Equipment Corporation et. al.

Host PC. The notebook PC or tower PC to which the Patient Interface Unit is connected by means of the USB cable.

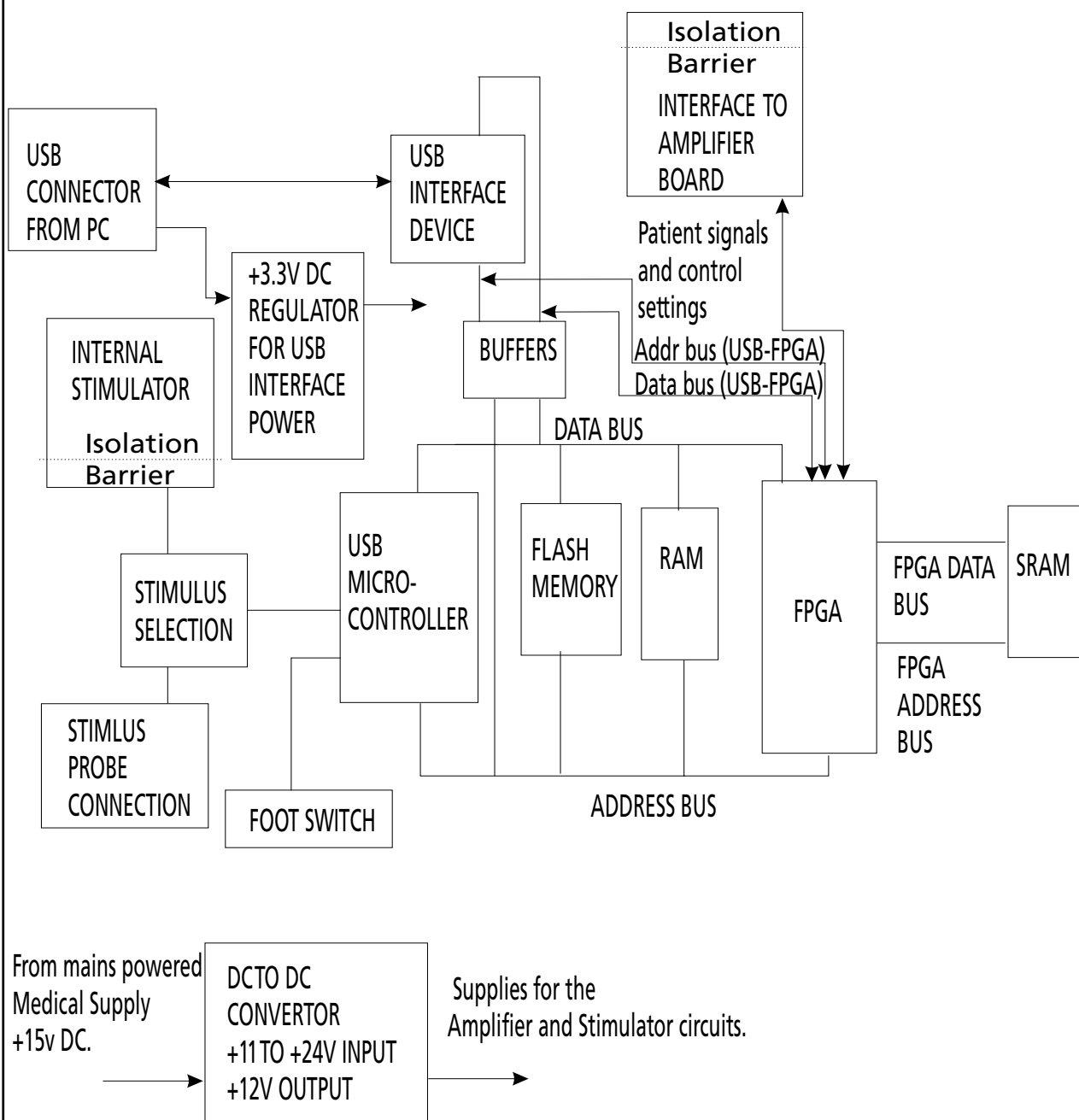


Figure 5.3 PIU USB interface, control circuits, DC-DC converter and Selection circuits for internal stimulators

5.4 Patient Interface Unit Overview

The electronics of the Patient Interface Unit (**PIU**) is contained on two printed circuit boards. One of these boards houses the amplifier and analogue to digital converter along with a microcontroller that controls the settings used by the amplifier. The second board houses the USB interface and stimulator. Physically the two boards are mounted one on top of the other.

An external medical grade power supply provides 15 volts DC that is used to generate isolated supplies for the amplifier and stimulator sections. The amplifier has two channels and provides gain and filtering. The analogue to digital converter operates at a sample rate of 50kHz and has a 16 bit resolution. The digitised data is fed to the USB interface section as a high speed serial bitstream.

This in turn buffers the data in memory, encapsulates it and stimulus timing information into data packets, and places these onto the USB. The internal stimulator provides constant voltage and constant current mode stimulation. Control data is sent from the notebook PC to the Patient Interface Unit over the USB. A microcontroller handles this data and transfers it onwards to the amplifier or stimulator which both have internal PIC microcontrollers.

Stimulus pulse generation is controlled by data sent to the Patient Interface Unit over the USB.

5.4.1 USB Interface

The USB interface (see figure 5.3) operates at the full rate of 12Mbps/sec. A special "USB Interface chip" handles the USB protocol, NRZ encoding and bit stuffing / clock recovery of the outgoing and incoming data.

Power for the majority of this section is provided from the notebook PC by means of the USB cable at a nominal 5 volts. As this can drop to 4.4 volts, a low dropout, low standby current, regulator is used to provide 3.3 volts to the USB Interface circuits. This scheme ensures that the host can still interrogate the Patient Interface Unit, even if the external power supply is not plugged in or turned on. Approximately 120mA is drawn from the notebook with this section fully configured and operational.

A **Microcontroller** is used at the heart of this system. After reset it sets up the registers in the **USB Interface Device**, and then configures the FPGA and its software. The microcontroller has an external 128k byte flash ROM program memory which is configured as two 64k byte pages. A jumper selects the active page. The low page contains test software. In addition an external 32k byte static memory is provided for general purpose storage. The microcontroller has two internal universal asynchronous receiver transmitters (UARTS). One of these is used to communicate with the PIC microcontroller in the amplifier, and the other with PIC microcontroller in the stimulator. Note that an Deluxe Stimulator Probe can be used instead of the internal one.

A field programmable gate array (FPGA) is used to process the data from the Analogue to Digital converter. As these devices are volatile, the USB Microcontroller has first to configure (i.e. program) the device. This it does by requesting the FPGA configuration file from the host PC, and writing the configuration data into the device. When configured, the FPGA handles the transfer of data from the amplifier onto the USB without further intervention of the USB Microcontroller. Internally the FPGA is arranged as special purpose microcontroller with a 24 bit instruction word. Program and data storage is provided by three 32k x 8 static CMOS memory chips which are arranged as 32k x 24 bits. After the FPGA has been configured, the USB Microcontroller must also load the FPGA's program into this memory.

Stimulus timing (repetition rate and duration), is also controlled by the FPGA. It is programmed to behave as pulse generator, this is more efficient than using an external counter/timer chip. The USB Microcontroller generates the control inputs to the FPGA by parameters received from the notebook PC software over the USB.

5.4.2 USB Microcontroller

The USB Interface Microcontroller is a ROM less, 3.3 volt, low power version of the industry standard 8051 microcontroller. It contains two UARTs, 256 bytes of RAM, 3 timers and a watchdog. Internally the core of the device differs from earlier versions in that it takes 4 clock cycles rather than 12 for each instruction. This gives a significant speed improvement.

Software access to all the internal peripherals is by means of Special Function Registers.

A multiplexed address and data bus provide the micro with access to program memory, extra RAM and peripherals. A transparent latch is used to de-multiplex the address and data signals. The microcontroller has two external address spaces. 64k Byte of space is required for program code and is accessed when the micro asserts the PSEN (Program Store ENable line). Note that the read or write lines, RD and WR are not asserted during program memory access. A standard 32k x 8 SRAM is provided for storage of parameters and variables.

This device is mapped into the lowest 32k of the second external address space. The RD and WR lines are asserted during data accesses to this space. The PSEN line remains de-asserted during this time. A Philips PAL is used to decode the various external device addresses.

Note that the USB Interface Microcontroller and all the associated logic operates at 3.3 volts.

5.4.3 Microcontroller Internal Peripherals: UARTs

The USB Interface Microcontroller has two internal UARTs. These are used to provide the control and setup information to the amplifier board, and the internal or external stimulator. One of the tasks of the software will be to handle this data flow. Serial port 0 is connected to the stimulator and serial port 1 is connected to the amplifier. Both serial ports operate at 9600 baud.

5.4.4 Microcontroller Internal Peripherals: Input Output Ports

The USB Interface Microcontroller has four 8 bit bi-directional ports. Two of these (ports 0 and 2) are utilised for the address and data bus and are therefore unavailable for general use. The other ports are both used to communicate with the footswitch, stim probe, RS232 with amplifier and stimulator. The ports are also used by the FPGA during configuration and interrupts from the USB Interface Device

5.4.5 USB Interface Device

The USB connectivity is provided by a dedicated USB Interface Device. The device has an 8 bit data bus interface and 5 address lines plus read, write and chip select etc. It requires a 48MHz clock, which is provided by a third overtone crystal. A series LC circuit provides a low impedance path to the 16MHz fundamental frequency. Since access to the device is shared between the USB microcontroller and the FPGA, buffers are used to isolate the USB Interface Device signals from the USB microcontroller at all times except when the microcontroller needs to access the device. Arbitration of this access is controlled by the software. Normally the FPGA has access to the USB Interface Device, but when it has completed the data transfer for a given frame, it generates an interrupt to the USB Interface Microcontroller to indicate that the remainder of the frame time is available for serial port messages etc. The PAL generates the control signals for the buffers.

5.5 Amplifier Interface

A 10 pin and a 14 pin header, mounted on the component side of the USB board, mate with 10 and 14 pin sockets on the underside of the amplifier board. The 10 pin header carries +12 volts to power the amplifier also the clock, frame, data, sync and 'RS232' signals from the amplifier. The 14 pin connector carries the isolated amplifier inputs to input sockets, which for convenience are mounted in an isolated section of the USB board.

Three signals carry the digitised amplifier data. These are the serial data bitstream, a synchronous 3.2MHz clock, and the strobe or 'frame' signal that de-limits each block of 32 data bits. Two additional signals are used to synchronise the switched mode power supplies for the +12 volt and stimulator.

5.5.1 FPGA Operation and Configuration

The FPGA is a volatile device. (ie its configuration is lost when the power supply is removed). This has the advantage that the device can be re-configured in the field by means of a software update. The disadvantage is that the device must be programmed (configured) every time that the unit is switched on. The three configuration mode selection pins have been set for asynchronous peripheral mode configuration. In this mode the configuration data is supplied, one byte at a time to the FPGA. A busy signal is polled by the USB microcontroller to establish when the next byte may be loaded. The signal is asserted when the configuration phase is complete.

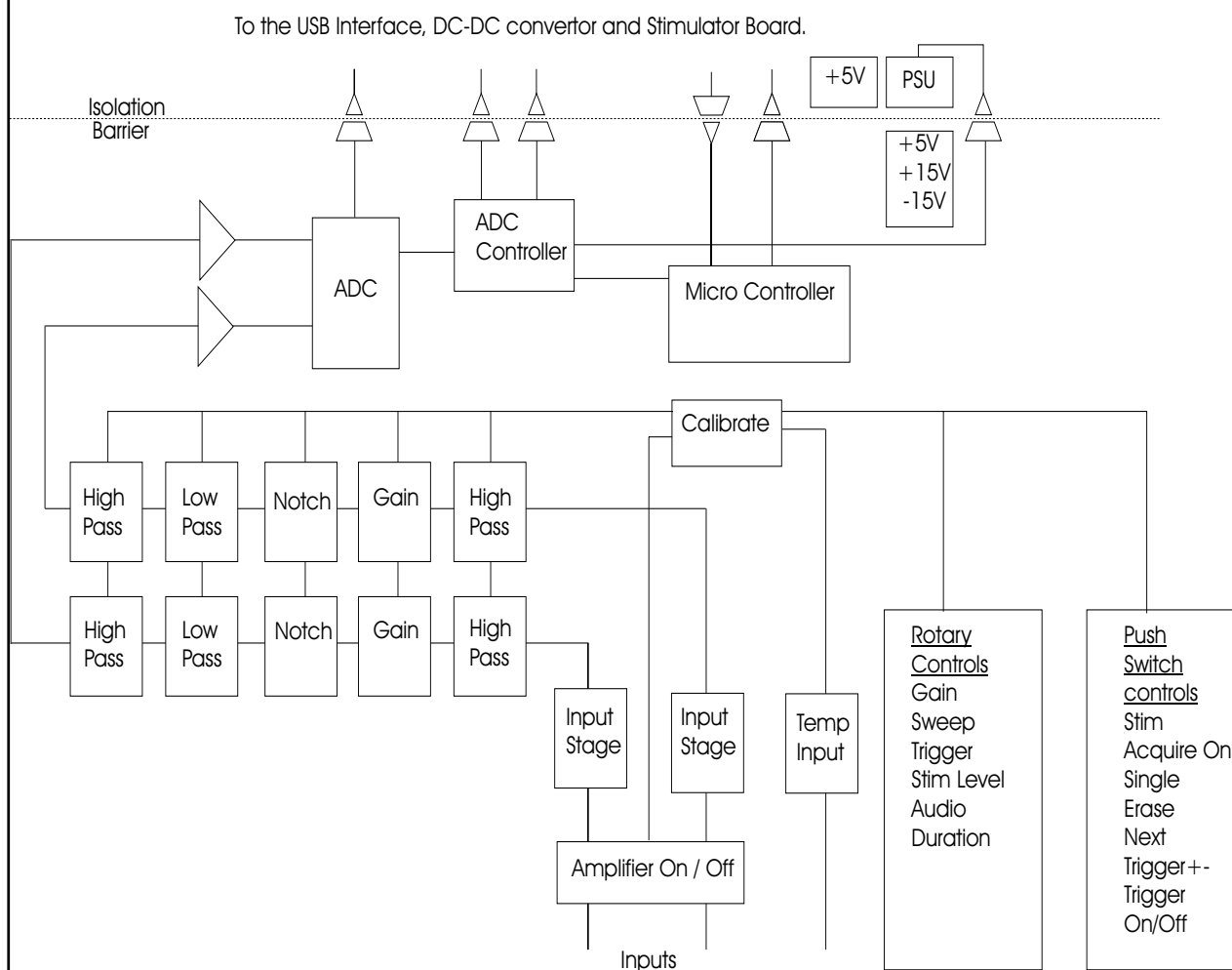


Figure 5.4 Amplifier and control panel electronics block diagram

5.5.2 FPGA Program Memory Configuration

Once the FPGA has been configured, its program memory must be loaded with the program that it is to run. This is achieved by accessing the FPGA's internal registers. The FPGA software is downloaded from notebook PC. This gives additional flexibility during the life of the product.

5.5.3 Stimulus Pulse Generation and Selection

According to user stim requirements commands are sent from the PC via the USB and USB Interface Device to the USB Interface Microcontroller. This in turn sets up the FPGA to provide the stim repetition rate and durations timing pulses.

Counters in the FPGA generate output pulses with a duration between 50 μ s and 1ms at a repetition rate between 0.1Hz and 5Hz.

5.5.4 Internal and External Stimulator Selection

It is necessary to select either the internal stimulator, or an Deluxe Stimulator Probe. The probe is a standard part that is currently used with other members of the Synergy family.

The stim drive, stim select, stim polarity and RS232 signals are buffered to translate between the 3.3v and the 5volts. Similarly, probe detect and RS232 signals from the probe are translated from the 5v to 3.3volts.

A signal selects the internal stimulator when asserted. Asserting this signal directs the stimulus pulse drive signal and the RS232 signals to the internal stimulator. It also activates the stim power supply switching circuit to provide a 12 volt supply feed to the internal stimulator. Note that there will be a delay after the supply is turned on before the stimulator will be functional.

When the internal stimulator signal is de-asserted the stimulus signals are directed to the stimulus probe. This disables the supply to the internal stimulator, and enables the supply to the probe. The connections to the probe are by means of a filtered 9 way D type socket. A probe present signal will be low if the probe is plugged in and high otherwise. The signal STIM_POL is provided to select the polarity of the probe outputs. This signal has no effect when the internal stimulator is selected.

The diodes are used to provide ESD protection for the signals /PROBE_PRESENT and PROBE_PSU_SYNC connections.

The RS232 signals to the probe require proper RS232 levels (unlike the internal stimulator which uses TTL signaling). The level conversion is achieved by a special i.c which has an internal charge pump to generate the RS232 level supplies.

5.5.5 PCB Revision and Power Status

A buffer i.c is connected to the USB Interface Microcontroller data bus. The 6 LSB inputs of the buffer are controlled by pull-up and pull-down resistors and allow the software to read a hardware version number which is encoded by fitting the pull-up / pull-down resistors. The initial revision / build of the board will have hardware version 0. The two remaining inputs to the buffer are controlled by pull-up resistors and MOSFETS. The gates of the MOSFETS are connected to the +5 and +12 volt supplies. This allows the software to detect whether the external supply is operational. Note that since the USB microcontroller is powered from the USB host, this section of the electronics will operate even if the external DC supply is not switched on. The microcontrollers software can report this fact back to the PC, via the USB which in turn can notify the operator.

5.6 Amplifier electronics

The block diagram of the amplifier circuit is shown in figure 5.4. The amplifier circuit contains gain and filter stages. There is a single level of calibration voltage. The high pass filter settings have been changed to 0.1 1.0 3.0 10 20 100 and 500Hz. The gain stage feeds a notch filter which has three states 50Hz, 60Hz and off. The low pass filter stage has values of 100, 200, 500Hz, 1, 2, 3, 5 and 10KHz. Following the low pass filter stage is another high pass filter which provides a DC blocking function to remove offsets. This filter has 3 settings 0.02, 0.5 and 5Hz. The signal then passes through a stage which level shifts and converts it to differential mode to drive the ADC. The ADC is a Delta Sigma stereo audio part with 20 bits resolution. Only 16 bits are used by the Synergy LT. The sample rate is 50KHz.

The amplifier filter and gain settings are controlled by the PIC. In addition the PIC also reads the controls and sends the appropriate control events to the USB interface.

5.6.1 Amplifier circuit description

The circuit will be described for channel one as the circuit for channel 2 is identical. The input signals from the DIN and touchproof sockets on the lower USB board come onto the amplifier board via a 14 pin connector. This connector is also used to connect the drive signals for the shields for the patient electrode wires and a common mode drive signal for use as a shield drive on the lower board. The input signal passes through a switch and then through the safety network of 390K in parallel with two 10uF capacitors in series which will limit any DC currents from the FET gate in the event of a failure. A switch is used to select the CAL signal instead of the input signal. The cal wave form will only appear if the amplifier is switched off and the command to enable the cal generator has been received. The signal passes through a pair of catching diodes which function so as to prevent high static voltages reaching the FET gates in the event of a discharge. The charge is dumped into the supply rails. The ends of the diodes are driven by the common mode signal to bootstrap out the diode capacitance. The 56pF caps on the FET gates are to help prevent RF detection taking place in order to increase the immunity to RF interference. The input stage is a standard FET input differential amplifier with a gain of 10. Common mode rejection trim is provided by a potentiometer. The signal then passes through a differential high pass filter. This filter arrangement doubles the series mode range of the input stage compared to a single ended version. Also the variations of offset normally seen with the single ended filter when the frequency is changed are virtually eliminated with this design. From the high pass filter the signal passes to a programmable gain stage, which also converts the signal to single ended. This circuit arrangement gives a high CMRR as the differential gain is $\times 2000$ but the common mode gain is only 1. This enables an overall CMRR of greater than 110dB to be reliably achieved.

The signal then passes through a notch filter which is switchable between 50 and 60Hz or off. One trim pot is provided to trim the 50Hz setting which also trims the 60 Hz setting as well. The circuit works by subtracting a filtered and inverted version of the signal from itself.

The signal then passes through a low pass filter with 8 settings. The filter is critically damped which provides the standard roll off used by clinicians over many years, and is equivalent to two buffered RC filters in series.

The signal then passes to a DC blocking stage with three cut off frequencies which are arranged to always be at least 4 times lower than the frequency selected for the high pass filter. i.e. 0.02Hz for 0.1 and 1Hz, 0.5Hz for 3 and 10Hz and 5Hz for 20, 100, and 500Hz. This prevents the roll offs combining and steepening the response.

The DC offset has to be removed from the signal as there is no digital filter to remove it in the mainframe.

The signal is also level shifted to 2.2 volts which is the common mode voltage of the ADC. This voltage is provided by the ADC. The Philips PAL provides the clocking signals for the ADC and the timing signals for the interface to the USB board. The output signals from the amp pass down the inter-board connector to the USB board

The signals for controlling all the filter and gain settings are loaded into the (4094) serial to parallel shift registers by the PIC. The PIC also generates the clock and reads all the front panel controls.

Amplification is provided for the temperature probe input and the amplified signal is feed to one of the ADC channels in the PIC. Another ADC channel is used for the audio volume control input.

5.7 Stimulator electronics

The electrical stimulator is intended to be used in myography measurements to provide nerve stimulation and / or muscle contraction. It does so by providing electrical current through the skin of the patient close to the nerve or muscle under investigation. The applied electrical stimulus pulse can be either constant current or constant voltage: "Constant current" means that during the stim pulse the voltage between the 2 stimulator tips is adjusted to allow the selected amount of current to flow. "Constant voltage" means that the applied voltage between the stim probe tips is constant during the stimulus pulse.

The Stimulator electronics, see figure 5.5, is fully isolated from other circuits in the PIU. Control signals to and from the stimulator are routed through opto isolators. An isolated power supply provides outputs of +12V, +5V and -12V.

The stimulus type, amplitude, frequency and duration is controlled from the notebook PC required stimulus timing duration and repetition rate is generated by the FPGA.

The electrical stimulator electronics is controlled locally with a PIC microprocessor. This microprocessor sets the amplitude of the stimulus pulse. This is achieved by loading data into the DACs, the outputs of these feed the voltage or current sources to give the required outputs.

The stimulus pulse is initiated by sending a trigger pulse on the stim trigger line. This turns on the fets which form the stim output switching circuits. These connect the stimulus voltage or current to the patient.

This Stim PIC microprocessor sets the amplitude of the stimulus pulse. In current mode the amplitude can be set from 0-100mA in voltage mode from 0-300V. The voltage and current is set by the PIC via the dual DAC using output A to control the voltage and output B the current. During current stimulation the voltage source is set to 300V and the current sink is set to the required level. During voltage stimulation the current source is set to 100mA and the voltage source set to the required level.

A second task of the PIC microprocessor is to monitor the stims via the feedback and Stim fail and error checking circuits.

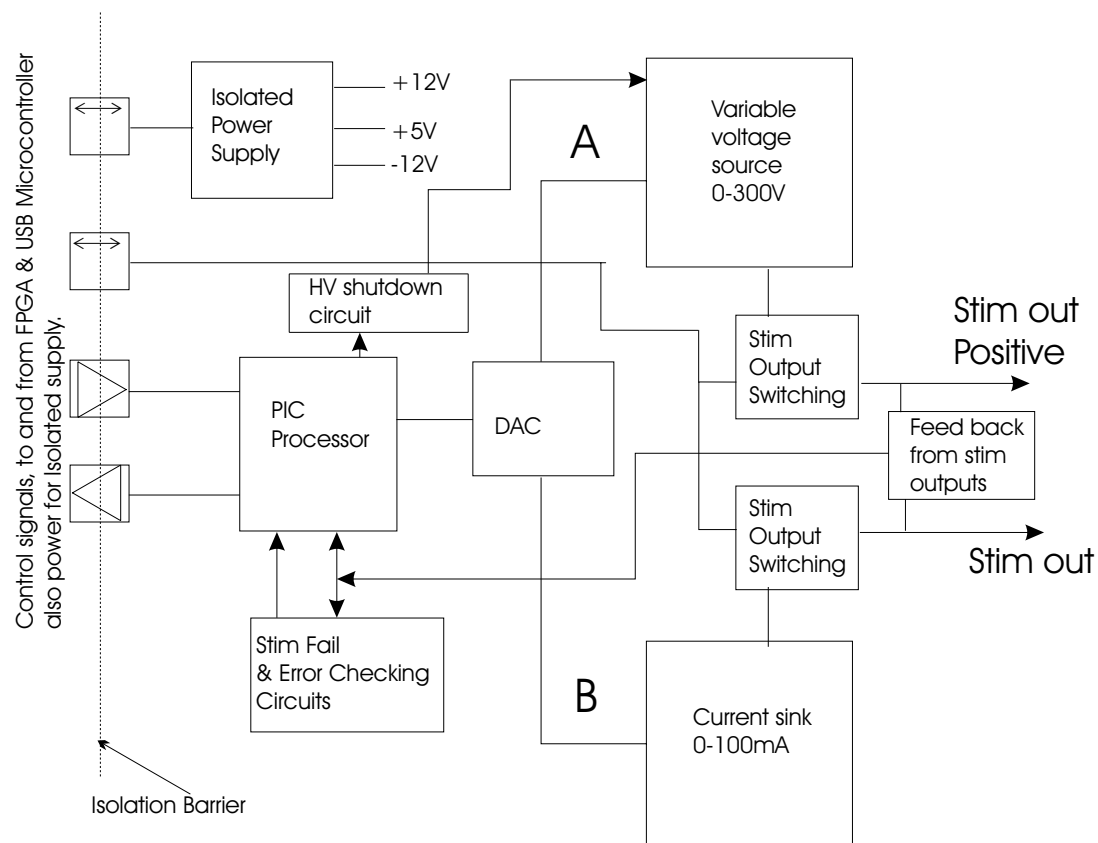


Figure 5.5 Block diagram of stimulator

The stimulus pulse is verified as being sent with the correct amplitude and that the allowable mark space ratio has not been exceeded. If not, the Stim PIC microprocessor will report this to the main unit and will disable further stimulus pulses until the problem is resolved and the notebook PC sends a stim enable command to re-enable the stimulator. The PIC also monitors stim failures and reports these to the mainframe.

The user has a high and a low range of stimulus amplitudes to choose from. Due to the use of a 12 bit digital to analogue converter it is possible to adjust the amplitude in 2048 steps. Thus the hardware has enough resolution in the DAC system to implement the fine resolution for the low range without changing ranges in the hardware. The user interface will provide a low range providing fine control (0.3V and 0.1mA) and a high range giving coarser control (3V and 1mA).

5.7.1 Stimulator monitoring functions.

The following are monitored to ensure that correct stimulation is delivered and as a constant check on the correct functioning of the stimulator electronics:-

Current set detect:

During current mode the DAC B output voltage is verified by the PIC's ADC by monitoring of the feedback level. This is done by the PIC every 20 ms. If the value measured is greater than the value requested by more than 10% (plus an offset of 12V for the voltage mode and 4mA for the current mode) the stim pulse is inhibited and the high voltage supply shut down. An overcurrent message is sent to the mainframe and the stimulator will remain shut down until the mainframe issues a stim enable command.

Voltage set detect:

During voltage mode the DAC A output voltage can be verified by the PIC's ADC by monitoring the feed back level. This is done by the PIC every 20 ms. If the value measured is greater than the value requested by more than 10% (plus an offset of 12V for the voltage mode and 4mA for the current mode) the stim pulse is inhibited the high voltage power supply shut down and an over voltage message sent to the mainframe. The stimulator will remain shut down until the mainframe issues a stim enable command.

Fault current detect:

In both voltage and current mode the voltage measured should always be 0V outside the stim trigger time. This will be verified by the PIC every 20ms. When the value is not 0V the stim pulse will be inhibited, the HV power supply will be shut down and the main frame will be informed by sending a fault current message. The stimulator will remain shut down until it receives a stim enable command.

Stim fail detect :

In current mode the stim fail detect will indicate that the current demanded cannot be delivered to the patient. This is due to the impedance at the stim tips being so high that the voltage between the tips would need to exceed the maximum available (300V) to supply the demanded current. This will cause the stim fail circuit to signal the Stim PIC which in turn indicates a "stim fail" to the notebook PC . The screen display will show a the message "stim fail" indicating to the user that the impedance at the stim tips is too high to deliver the current requested.

In voltage mode the stim fail line should always be low during a stim pulse since the current limit should not be reached. If the current limit is reached the stim fail line will go high . This indicates that the load impedance is too low to reach the set voltage, which is a voltage stim fail. A stim fail message will be send to the notebook PC .

In both voltage and current modes the PIC will look at the Stim fail line once every 20 ms. If a stim fail is detected the PIC will generate a stim fail event and then cease to monitor the stim fail line for 1 second. If on returning the stim fail line is still indicating a fail another stim fail event will be generated provided that another stimulus pulse has occurred in the meantime. This will prevent the PIC generating fast unnecessary stim fail events.

Duty cycle limiting:

This is necessary to protect the patient from receiving too much electrical energy during high stimulus frequencies also to avoid overloading the electronics. Duty cycle limiting is accomplished by monitoring the "Stim trig monitor" signal with an integrator \ follower amplifier circuit. The voltage at the output of this circuit is proportional to the duty cycle of the stim pulses. It is fed and sampled every 20 ms by one of the PIC's ADC inputs.

When this voltage indicates that the duty cycle of 20 to 1 has been exceeded, the PIC will shut down the power supply and inhibit further stim pulses by setting both the DAC's to 0V. The software in the mainframe will also check that the 20 to 1 duty cycle has not been exceeded when sending trigger pulses to the stimulator.

5.7.2 Shutdown of the HV supply.

The HV supply is normally off but held on by the PIC continually toggling the shut down line. This is achieved by AC coupling of the signal to the FET shutdown circuit. This produces two shut down signals for safety purposes.

The PIC processor toggles shut down line every time the program passes through the 4ms interrupt routine. In case of a failure condition the PIC will stop the toggling shut down line and the FET shutdown circuit outputs will reach 1-2V. This voltage turns on other MOSFETs which disable the high voltage power supply and discharge the storage capacitor.

This shut down situation will also occur if the processor crashes for any reason. A crashed processor will be stuck inside a program loop and will not provide the 4 ms pulses to prevent shut down.

5.8 DC - DC CONVERTER**5.8.1 Overview**

An external, Medical Grade switch mode supply is used to power the **Patient Interface Unit**. A DC - DC converter is utilised to convert this to a stable 12 volt supply for use by the Patient Interface Unit electronics.

5.8.2 DC - DC Converter Design Description

The design is based around a push-pull transformer-coupled forward converter topology. This arrangement was chosen because it allows the input voltage to range both above and below the output voltage.

A wide input voltage range capability of +11V to +24V has been designed in to cope with future changes in supply requirements. An inductor capacitor filter is used to reduce the level of switching artifacts fed back.

The converter supplies +12V dc power to the Electrical Stimulator and the 2 Ch. Amplifier.

The control i.c. used is a voltage mode pwm controller.

The internal oscillator is set to free-run just below 200kHz. A 200kHz +ve going TTL level sync signal of 300-500ns wide pulses is applied to the sync input to lock the power supply to the Amplifier data rate.

The outputs of the control i.c drive MOSFETs via current limiting resistors to provide the output drive currents.

The drains of MOSFETs drive the primaries of the transformer in push-pull. The transformer has a step up ratio of 1:1.7 from primary to secondary.

On the secondary side of the transformer diodes conduct alternately during the on periods of the MOSFETs. The diodes are followed by an LC filter. Energy is stored in the inductor during the on periods of the MOSFETs and this stored energy is supplied to the load during the MOSFET off periods. The capacitor acts as an output filter and reservoir capacitor.

Voltage feedback is taken from the +ve end of the reservoir capacitor through the resistor network to the inverting input of the error amplifier in the control i.c. The control i.c also has associated resistor and capacitor compensation components.

A resistance of 0R41 in the sources of the MOSFETs is used to sense their drain current. An R/C circuit filters the waveform across 0R41 to prevent false triggering of the current limit circuit. The drain current is limited to approximately 2A.

A shutdown circuit is provided which will prevent the +12V supply starting up if there is no +5V provided by the USB connection. It will also shutdown if the +5V USB power supply fails.

Because the input voltage can vary between +11V and +24V the gate drive circuit for MOSFET derives its supply from the stabilized +12V output so that the peak current to charge the MOSFET gate input capacitance and the Miller capacitance remains constant. At switch on, in order to allow the converter to start up, the gate drive supply is taken initially from the output of a linear regulator which provides +8V. This +8V is supplied via a diode and resistor to the power Vc pin of the control i.c. Once the +12V output is established it is fed via another diode to the Vc pin. The first diode is then reverse biased by the +12V feed through the second diode and thus the +8V startup feed is disabled.

The compensation components are required to counter the effects of the 2 poles in the output L-C filter, the zero caused by the esr of output reservoir capacitor, and the pole of the error amplifier. In addition a pole at half the switching frequency is included to minimize high frequency noise at the pwm input inside the control i.c.

TECHNICAL OVERVIEW PLINTH SYSTEM

6.1 Scope of Plinth overview

This section covers the following areas:-

A description of the Synergy Systems with **Plinth** which are multitasking PC based systems controlled by a Pentium processor in either a **tower PC** or a **notebook PC**

A description of the **Plinth** with the option of the visual and auditory EP Stimuli.

A description of the **Control panel**, which contains an internal pointing device and the Control Panel EMG electrical stimulator

The use of one or two external hand held Deluxe Stimulator probes.

An overall schematic diagram of the systems is shown in Figure 6.1 and 6.2. The main differences between the systems is the way in which they must be powered.

Note the use of the Isolating Transformer in the Tower systems.

Also the DC to DC "Universal Auto/Air™ Power Adaptor" which supplies DC power from the Plinth to Notebook PC in notebook systems.

Further block diagrams and simplified descriptions of functional sections are provided in this chapter to aid understanding. The **Plinth** system also has a small control panel, which contains an internal pointing device and the Control Panel EMG electrical stimulator. The plinth system uses the separate 2, 5 or 10 channel Synergy Amplifier. Synergy systems with **Plinth** also have the option of the visual and auditory **EP** Stimuli.

This does not imply that there are distributor or user replaceable parts within the Plinth (due to the SMT components).

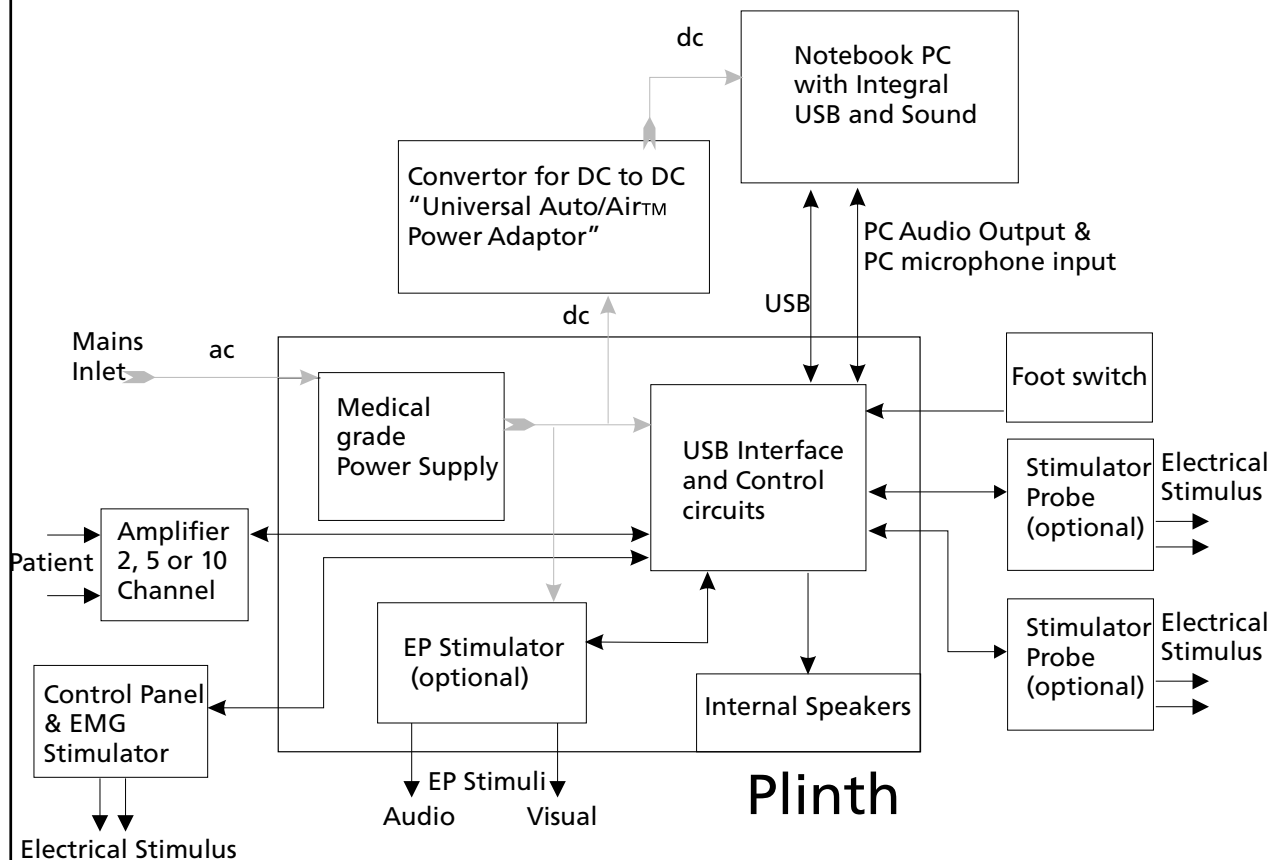


Figure 6.1 Notebook Plinth System block diagram

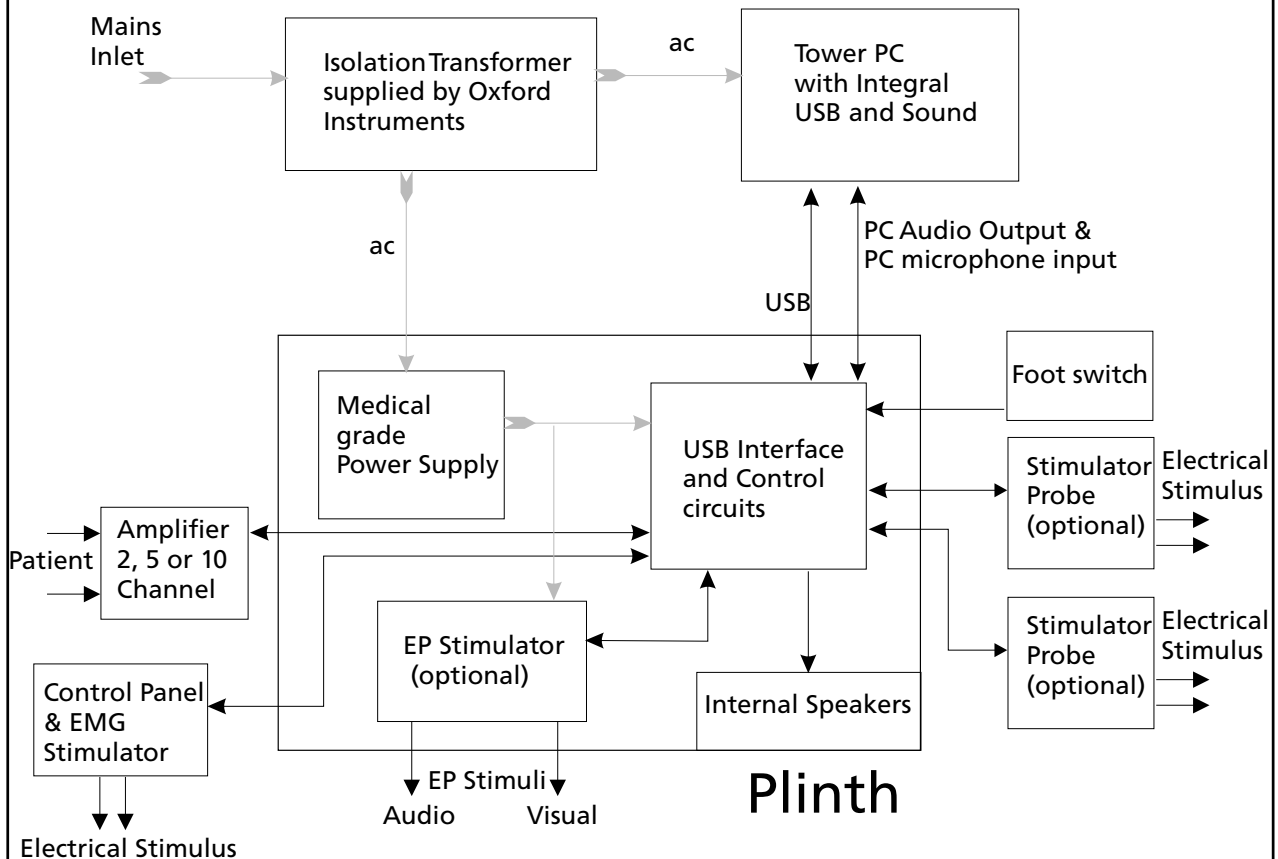


Figure 6.2 Plinth Tower System block diagram

6.2 The PC

The processor speed and the specification of the PC for a particular system will depend on the model of PC available at the time the system was purchased.

Current Tower PCs are 1GHz, P3s with 265Mb of memory.

Current Notebook PCs are 750MHz, P3s with 64Mb of memory 10Gb hard drives.

The minimum PC memory installed is 64MByte, additional HP approved compatible memory can be installed if required.

In all systems Primary and secondary enhanced IDE controllers are built into the PC these are used for the hard disk and CD-ROM drive. There is a separate controller for the floppy disk drive. In the **Notebook**, PC card Slots (PCMCIA) can be used for optional expansion of the PC's functions. There is space for two 5mm Type 2 cards or one 10.5mm Type 3 card. The slots support 16 bit PC cards including PC card 16's and Cardbus PC cards. Cardbus supports the new standard 32bit standard PC cards. There is an Infrared port (IrDA 1.1) for cableless data transfer. There is one enhanced serial port, one enhanced parallel port and one PS/2 connector for the mouse / keyboard.
Note Only optional cards approved by Oxford Instruments Medical Ltd may be used.

6.3

6.4 The Plinth

6.4.1 Introduction to Plinth

The patient responses are amplified in the headbox. Then passed by the electronics **Plinth** to the PC where the signal is processed displayed and recorded.

This description includes sections dealing with digitisation of the patient signals, the interface to the PC by means of the Universal Serial Bus (USB) and the optional EP stimulator.

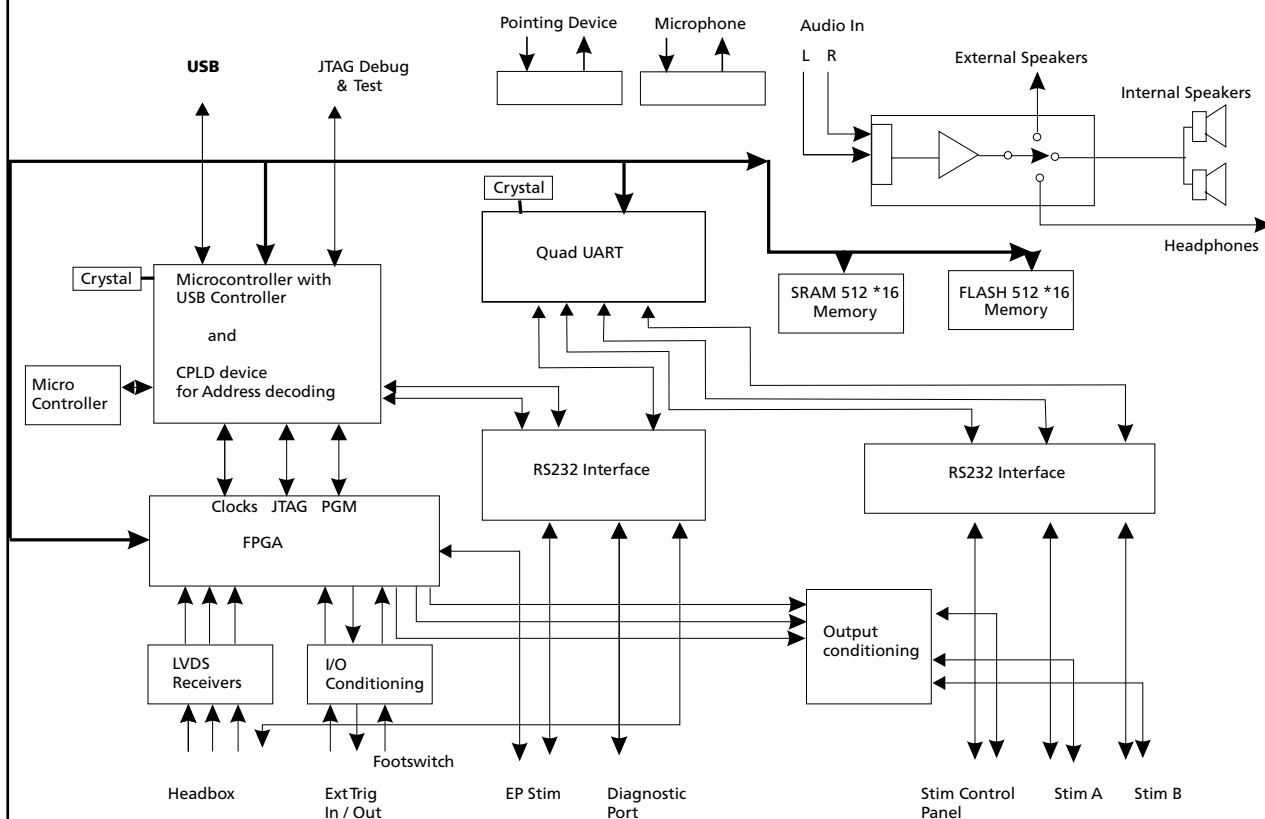
The methods of electrical isolation and power distribution between these sections is crucial to maintaining patient safety.

Figure 6.3 shows a block diagram Control circuits and the USB Interface within the Plinth.

Definitions

Universal Serial Bus. As defined in the document "Universal Serial Bus Specification" Revision 1 dated 15th January 1996 by Compaq, Digital Equipment Corporation et. al.

Host PC. The notebook PC or tower PC to which the Plinth is connected by means of the USB cable.



6.3 Diagram of Plinth Control circuits and USB Interface

6.4.2 **Plinth Control and Interface circuits**

Upper USB board Circuit Description

The main micro-controller is programmed at start up by the PC and the Synergy Software. The main micro-controller also contains the USB interface.

A Complex Programmed Logic Device (CPLD) is used to provide address decoding and timing control for the main micro-controller.

The main micro-controller has a main CPU clock of 24 MHz. This clock is filtered also routed to other parts of the circuit. The micro-controller has a 24 bit address bus and a 16 bit data bus.

A supervisory IC is used to generate the power-on reset signal at any time that the dc supply drops below a set value.

This device also contains a watchdog timer which will cause a reset to be generated if the not toggled regularly. During debugging this can be by passed.

For debugging only an emulator connection is made by means of a 14 pin header. Pull-ups on the JTAG signals are provided as recommended. Provided that the main micro-controller device and oscillator have power then it can be made functional. It is then possible through the emulator port to stimulate / sample any of the devices connected to it. Thus for instance it is possible to test or program memory without there being any firmware resident on the board.

A separate JTAG chain is used for CPLD programming and for additional board testing. This chain has the CPLD and the FPGA in it.

A comparator is used to generate a square wave whose frequency can be measured by the micro-controller. The frequency setting components are a resistor and capacitor. The resistor is a conventional wire ended device that is easy to change. It is intended if the hardware is changed, a different value of resistor will be fitted. This will allow the software to ascertain the hardware version number. The oscillator is stopped to prevent breakthrough after the initial measurement.

The main micro-controllers requires RAM and ROM. Two 256k x 16 fast static RAMs are provided. They are connected to a set of buffered address lines, and directly to the micro-controllers data lines.

Two 256k x 16 Flash ROMs are fitted for the firmware. These devices are fed via a buffer in order to prevent bus contention in the cycle following a ROM access. This devices are programmed in situ using a JTAG emulator and PC.

The quad UART has four, full duplex, asynchronous serial interface channels and associated handshake signals. Channel A provides the control to/from the amplifier, channels B and C are for the two stimulus probes. Channel D is for the combined control panel/stimulator. This mapping is identical to that used with the DSP sub-board used in other Synergy systems.

The handshake signals are connected to UART such that the software can determine whether the peripherals (i.e. amplifier, stim probes, control panel) are plugged in. The maximum clock frequency of the UART is 8 MHz, and so a separate crystal is included for baud rate generation. Translation of the voltage levels from 3V logic to RS232 is achieved by a driver device. This device has an integral charge pump to provide the proper RS232 voltage levels. Each of the four UART channels has an active high interrupt signal. These are inverted by and fed to the interrupt inputs on the main micro controller. The UART is reset by the CPLD.

The amplifier data LVDS receivers and a 30,000 gate FPGA get data from the 2, 5 and 10 channel amplifiers. The receiver has 100 ohm termination resistors are fitted on each of the LVDS data pairs. Additional 100 ohm series resistors have been included to limit the current into the device in the event of an electrostatic discharge at the amplifier connector. A buffered signal is used to synchronise their internal switched mode PSU and the Stim probes to the amplifier A to D clock. This helps to minimise interference.

The FPGA will be configured, by the main micro-controller using data provided from the host PC via the USB interface. In Express Mode data is provided to the FPGA a byte at a time, and it is then internally serialised for distribution to the configuration matrix. The whole of port 7 on the micro-controller is used for the data path, and the four control/status signals (init, done, cclk and program) are connected to ports 5.0, 5.1, 6.0 and 6.1 respectively. The 'init' signal is an open-drain type and thus a pull-up resistor, R1 is required. Four resistors determine which configuration method the FPGA will use.

The FPGA is configured to give a superset of the functionality provided by the 6,000 and 10,000 gate FPGAs in the existing Synergy Portable and Mobile units. Briefly, these functions are as follows:-

Reception and de-serialisation of the amplifier data. When in 10 channel mode this amounts to 160 bits (10 x 16) every 50 micro-seconds. The data is (at least) double buffered and then transferred to the fast SRAM using channel 0 of the main micro-controller DMA controller.

Generation of the stimulus timing signals. Support for three bi-phasic EMG type stimulators, and four EP channels is provided. Every stimulus delivered is tagged and marked such that the system software can correlate the instant of stimulus delivery to a data sample.

Two 'trigger in' signals of selectable polarity and two 'trigger out' signals, also with selectable polarity are provided.

The three footswitch inputs and input from the Patient Response Unit are de-bounced. Also any changes are 'tagged' to the amplifier data stream.

Sets of registers are defined within the FPGA that allow the system software to control the stimulus parameters, read the amplifier data etc. The FPGA is connected to the system data bus via a bi-directional 16 bit buffer and to the system address bus by address lines.

The amplifiers inputs and outputs connector is the same 26 pin socket used in the rest of the Synergy range. Plus and minus 12 Volt supplies are provided for the amplifiers through surface mount 1 Amp PolySwitches. This is identical to the arrangement on the DSP daughter board.

ESD devices are provided to reduce the possibility of circuit damage. These devices have a 6.1 Volt clamp level, and are IEC61000-4-2:level 4 compliant (16kV air discharge, 9kV contact discharge).

The USB connector is type B USB. Ferrite bead EMC filters are provided on the ground and 'Vbus' connections. A chip provides ESD protection for the USB port. This device is specifically designed for the protection of USB ports. Resistors provide the bus termination. A chip and resistor allow the system software to connect/disconnect the enumeration request resistor. A FET, is designed to sense the presence of the USB power, and hence allow the software to tell whether the bus is plugged in or not.

A filtered, 9 pin D type socket and carries the signals from the footswitch unit. A chip gives ESD protection to these signals.

The trigger in and trigger out connector is a filtered 9 way D type socket. 24 Volts is available through a 100mA PolySwitch for powering the Patient Response Unit or any other interface adapter.

The trigger input signals are restrained to the range $-0.7V_{trg\_in}$ 24.7 V by the dual diodes. Resistors limit the current should these voltages be exceeded. Finally the Transils give ESD protection. These have a 30 Volt clamp level and can absorb a 400W, 10 micro-second current rise, 1000 micro-second current fall pulse.

After ESD protection and voltage limiting, the trigger input signals are fed to a comparator. A forward biased dual diode, is used to provide a reference level of 1.4 Volts to the comparator. A small amount of positive feedback via is included to speed up the transitions.

The trigger output signals are essentially 'open collector' using the transistors. However, pull-ups to +5 Volts are provided internally, along with diodes such that an external device could pull the signals to a higher level if required.

The maximum excursion of the trigger out signals is restricted by the diodes to $-0.7V_{trg\_out}$ 24.7 Volts. Resistors limit the current should these voltages be exceeded. The signal from the Patient Response Unit is a TTL level signal and uses a spare 6.1 Volt ESD clamp Transil

As these circuits are split on two boards a 34 way connector is used to carry power and signals to the lower PCB via a ribbon cable.

A 14 way connector is used to carry the signals to / from the EP stimulator.

A 3 way Molex connector joins to the 'power-on' LED on the front of the plinth.

A 3 way Molex connector joins to the to the cooling fan. For load matching reasons this is powered from the -12 Volt supply.

A Molex Connector carries the 6 power rails to the board from the PSU. These rails distributed over the PCB and de-coupling capacitors are used as required. Two LEDs indicate the presence of the 3.3 Volt and 5 Volts supplies respectively.

The lower USB board Circuit Description.

A captive, 34 way ribbon cable, soldered to the board at position, carries power and data to this PCB from the upper board. All the power supply rails (± 24 Volts, ± 12 Volts, +5 Volts and +3.3 Volts) are transferred along with their associated 0 Volt returns. To minimise volt drop and source impedance, all except the 3.3 and 5 volt rails utilise two cores of the ribbon cable.

Two 9 way, filtered, D type sockets for connection of the stimulus probes or IOM stimulator unit. Each socket has a +12 Volt feed, protected by a 1 Amp surface mount, PolySwitch.

Note : The +12 Volt power is only provided on the A and B sockets of the Plinth when there is a probe connected.

The bi-phasic stimulus timing signals are generated inside the FPGA on the upper PCB and are transferred to the lower board via the ribbon cable. Transistors invert the signals and convert them from 3.3 Volt logic levels to 5 volt levels. The signals are then presented to ESD protection devices. These clamp discharges to 6.1 Volts. Resistors limit the current flowing into the board from an ESD or the inadvertent connection of some other device.

A 15 way, filtered, D type socket for the connection of the combined control panel and stimulator. Again a +12 Volt feed to the socket is provided, fused at 1 Amp by another surface mount PolySwitch. (Note the +12V is only there if the probe is plugged in). A chip provides ESD protection for the signals on this connector.

An interface chip performs level translation for the three pairs of RS232 signals. These devices have internal ESD protection, so no further protection is provided.

A socket carries the low level audio signal from a microphone that can be plugged into the control panel. This signal is attenuated (to compensate for gain in the control panel), and fed to a 7 pin DIN socket for onward transmission to the PCs audio input. The PCs audio output is connected to the inputs of the audio amplifier.

A circuit amplifies the "headphones" output of the PC to a suitable level to drive internal or external loudspeakers or headphones.

The left and right input signals are mixed by a differential amplifier which avoids tying the PC headphone 0v to our 0v, so cutting down on ground loops.

The output amplifier is the same type as used in the EP Stim. It is run from +/-24v rails. This is because the nerve signals are very "peaky" and so +/-12v may not give sufficient volume before clipping.

When headphones are plugged in to the switched ¼" jack socket the loudspeakers are disconnected. A resistor in the phones common connection attenuates the signal to avoid damage to phones.

When an external speaker is plugged in, the internal ones are disconnected.

The internal speakers are capable of high power handling for their size.

6.5 Overview of the headboxes 2, 5 & 10 Channel

6.5.1 The Two Channel Headbox

Figure 6.4 shows a schematic diagram of the headbox assembly with both the Pre-amplifier and Control boards.

6.5.2 The Control Board

Communication with the PC is made via a Low Voltage Differential Signal (LVDS) link, which is used to set up the various headbox parameters e.g. sensitivity.

A switching regulator that is synchronised with the amplifier sampling system, is used to drive the primary of an isolating transformer. The transformer output is rectified and regulated to provide the required isolated d.c. supplies. Isolation of the various control and data signals is via several opto-isolators.

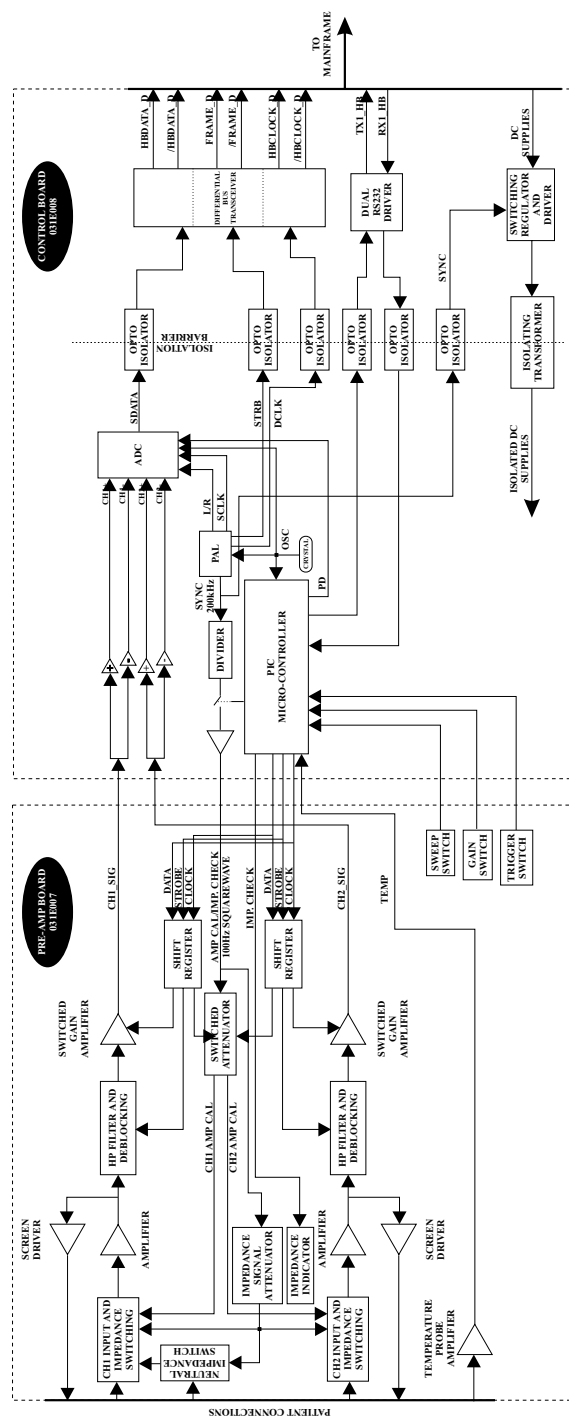
The headbox is controlled by a PIC micro-controller that interfaces with the LVDS port. The PIC also sends data in the form of a serial stream to shift registers on the preamplifier board to set up the amplifier, and controls the switching of the calibration signal.

The analogue patient signals from the Preamplifier are buffered on this board to provide differential signal inputs to the ADC, which digitises and serialises the signals under control of the PAL. The serialised data stream is returned to the Plinth via the along with a clock and strobe (frame) signal from the PAL. The Patient signals are sent from the Plinth via USB connection to be processed by the PC and displayed.

6.5.3 The Preamplifier Board

The serial data stream from the PIC on the Control Board is converted into parallel data by shift registers, and these signals control the switching of the gain and filters.

The patient signals are routed through input switches to the fixed-gain input amplifiers and then buffered to provide a screen driver. The amplified signals are then fed through high pass filters and switched-gain amplifiers before being sent to the Control Board.



When the amplifier is switched off by operation of a switch on the headbox, the PC is allowed to switch on the Impedance Check/Amp Cal oscillator circuit.

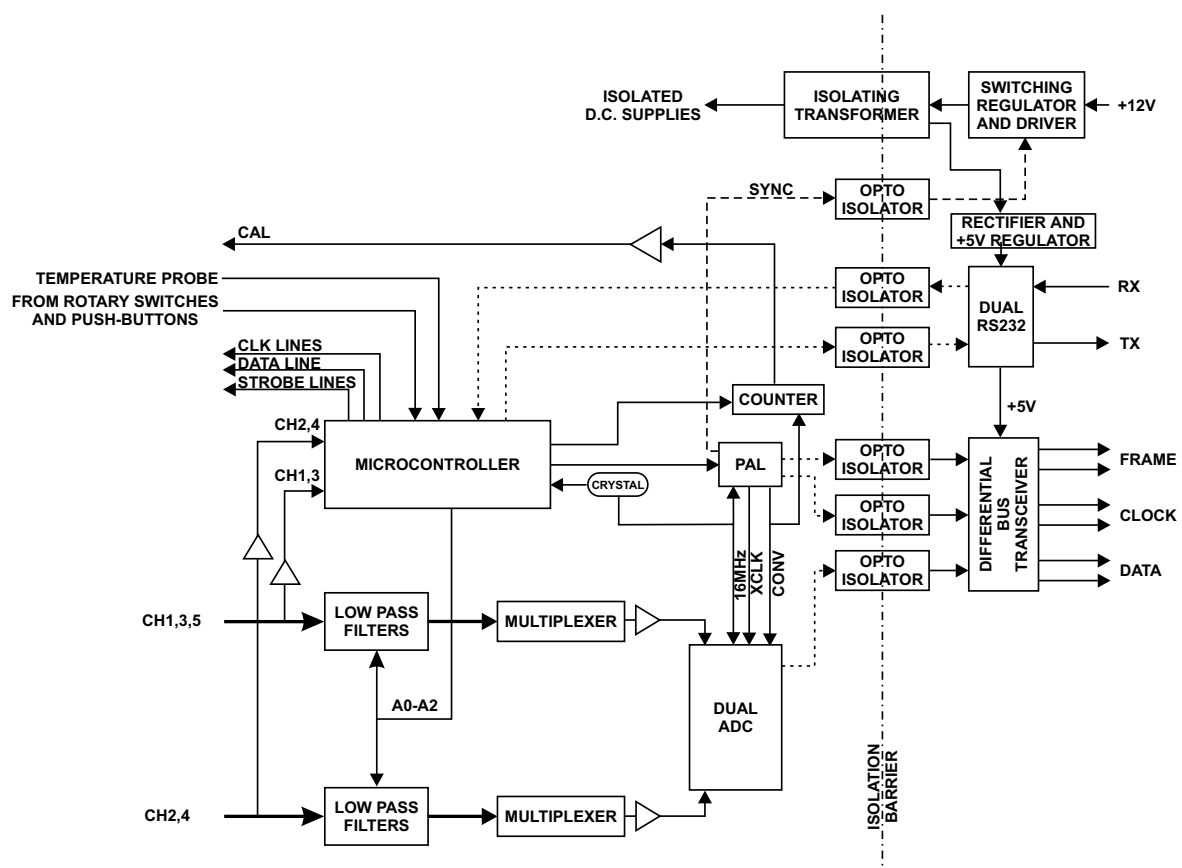
In Amp Cal mode (selected from the PC), the oscillator signal is connected to the Preamplifier inputs through switched attenuators controlled by signals from the PC via the PIC.

In Impedance Check mode, the oscillator signal is connected directly to the Preamplifier inputs (and hence any impedance across the input) via user operated push-button switches. These switches also indicate to the PC (via the PIC) that an impedance check is being made.

The oscillator signal is attenuated according to the level of impedance across the input (the patient) and is then processed by the PC as a normal patient signal by the to determine the level of signal attenuation. The PC then returns a signal to the headbox and the PIC outputs a signal to turn on the relevant impedance level indicator LED.

Three rotary switches on the board are used for setting the Sweep Speed, Gain, and Trigger Level. They operate by sending pulses to the PIC as they are rotated, and this information is returned to the PC. The Trigger Level switch also has a momentary push-button action that sends a signal to the PIC and PC to turn the trigger on and off.

The temperature probe amplifier monitors the changes in the resistance of the probe, and outputs an analogue signal that varies with changes in temperature. This signal is input directly to the PIC ADC which processes the signal into digital data that is fed back to the PC.



6.5 Diagram of 5 channel headbox control board

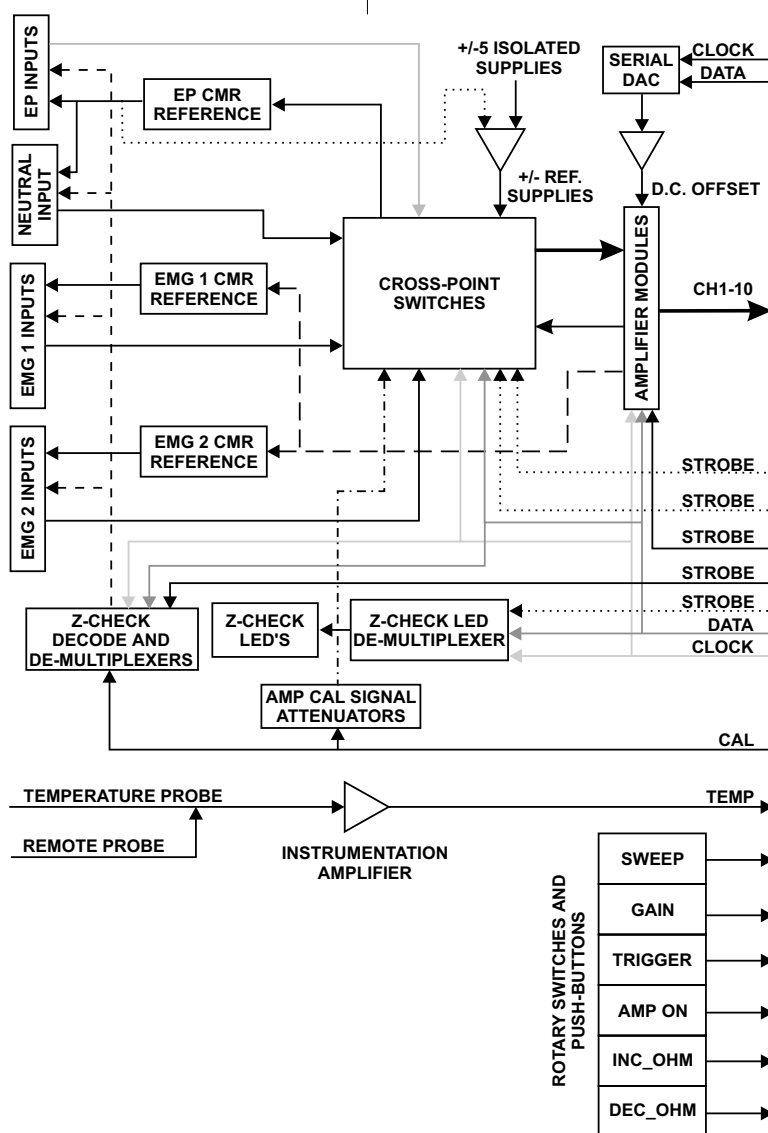
6.5.4 The 5 Channel Headbox

This headbox comprises a Control Board, Electrode Board, and Amplifier Modules that plug in to the Electrode Board. Block diagrams for these boards are shown separately.

6.5.5 The Control Board

Communication with the PC is via an LVDS link, which is used to set up the various headbox parameters e.g. sensitivity.

A switching regulator that is synchronised with the amplifier system, is used to drive the primary of an isolating transformer. The transformer output is rectified and regulated to provide the required isolated d.c. supplies. An extra output from the transformer is rectified and regulated to provide the +5V supply for the non-isolated circuitry. Isolation of the various control and data signals is made via several opto-isolators.



6.6 Diagram of 5 channel headbox Electrode board

The headbox is controlled by a PIC micro-controller that interfaces with the RS-232 port. The PIC also sends data in the form of a serial stream to shift registers on the amplifier modules to set up the amplifier, the high-pass filter and to switch in the d.c. offset as required.

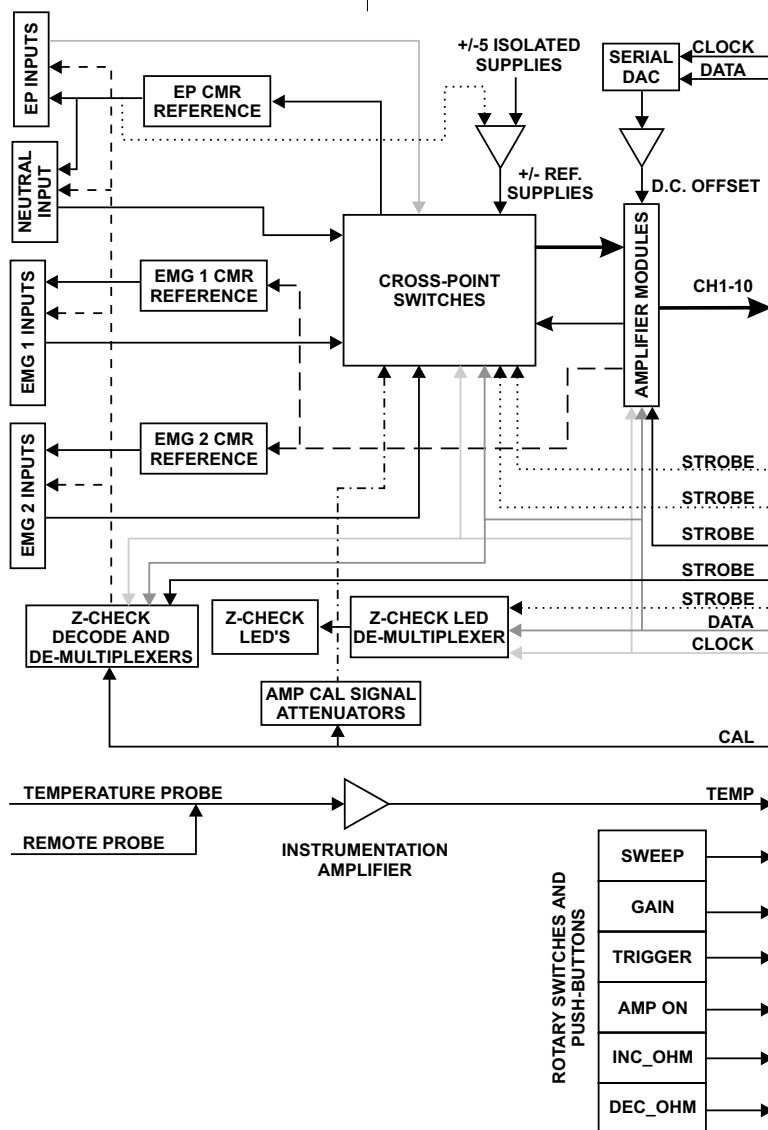
The analogue patient signals from the electrode board are low-pass filtered on this board and then multiplexed to both halves of the dual ADC, which digitises and serialises the signals under control of the PAL. The serialised data stream is returned to the PC along with a clock and strobe (frame) signal from the PAL, to be processed.

When D.C. Mode is selected, the PIC can remove the input offset. The first four amplifier channels are also input directly to four inputs on the PIC which are configured as ADC's. The PIC then outputs a serial stream of data to control the d.c. offset that is applied to the amplifier inputs. This is requested by the operator under software control.

A fifth input on the PIC is also configured as an ADC to monitor the analogue signal from the temperature probe.

6.5.6 The Electrode Board

There are 18 (+2 Neutral) EP electrode inputs and 2 (+ Neutral) EMG Channel inputs for the headbox that are input via this board.



6.6 Diagram of 5 channel headbox Electrode board

All inputs are routed to cross-point switches which determine which input is connected to which amplifier module as selected by the operator. The cross-point switches also route the common mode reference signals back from the amplifier modules to the screen driver for the EP Channel inputs. The reference signals from the EMG input amplifiers are routed directly to the EMG screen driver pins on the DIN socket.

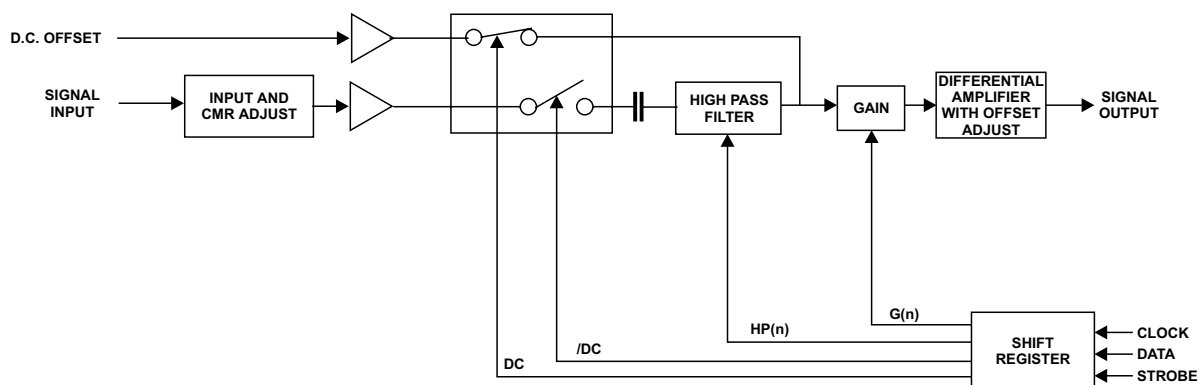
The cross-point switches are powered from a $\pm 10V$ supply bootstrapped by the common mode reference signal and derived from the isolated $+15V$ supply to compensate for capacitive loading of the signals within the switches.

The first four channels can be software configured to have a d.c. offset applied to their input stages which is derived from a quad channel serial DAC driven from the PIC on the Control Board. This is used to remove any offset up to $\pm 500mV$ present in the input signal.

The Cal signal from the Control Board is used both for input impedance testing and for the Amp Cal signal.

In Impedance Check mode the full amplitude signal passed through a $1M\Omega$ resistor is switched to each input in turn by a de-multiplexer. The signal from the amplifier is interpreted by the application software to determine the impedance at the input and compares it to the impedance level set by the operator. The PC then outputs data to the headbox which turns on the LED's in the headbox to indicate the impedance level for each channel.

In Amp Cal mode, the signal is attenuated by a chain of resistors and the reduced amplitude signal is routed to the input of the amplifier modules via the cross-point switches.



6.7 Diagram of one of the 5/10 channel amplifier modules

A temperature probe can be connected to the headbox via the Electrode Board. The probe signal is input to an instrumentation amplifier and then routed to the PIC on the Control Board. (There is also a connector for attaching an input from a remote headbox).

Various rotary and push-button controls on the headbox are located on the Electrode Board and are connected to the PIC on the Control Board.

6.5.7 The Amplifier Module

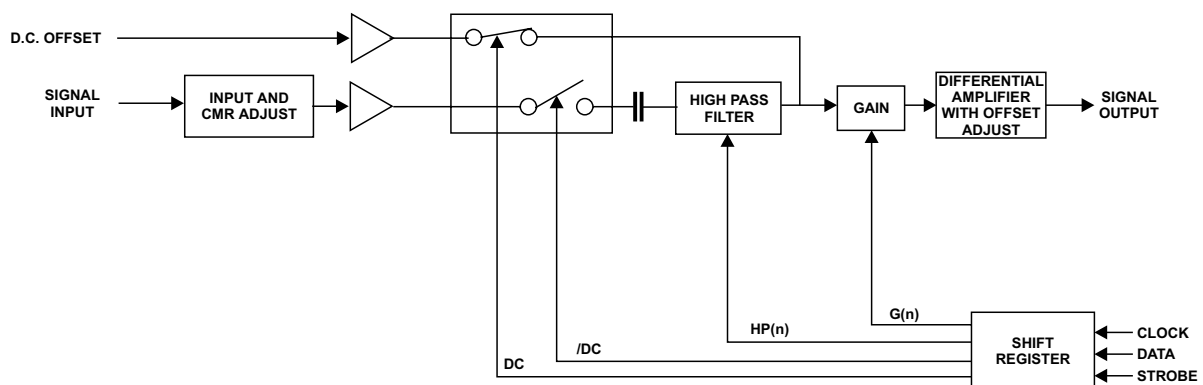
Each Amplifier Module contains two differential amplifier channels. The block diagram shown in Figure 6.7 shows one channel only, as both channels are identical. The pair of inputs are routed separately through the amplifier chain until the output stage of the module.

Common mode adjustment is provided at the input stage prior to the input buffers. The input signals are then fed to a high pass filter.

If the inputs to the first four amplifier channels are switched to D.C. (via the software) the D.C. offset from the DAC is switched in and added to the input signal, by-passing the high pass filter. The signal input to the high pass filter capacitor is disconnected when a d.c. offset is applied.

The high pass filter is followed by a gain stage which is followed by the differential amplifier stage. This stage has an offset adjustment for centering the amplifier output.

Control of the d.c. switching, high pass filter, and the gain stage are controlled by signals derived from a shift register. A serial data stream is clocked into the shift register of the first amplifier channel and then clocked out again into the input of the second channel. The same data stream is used to set up all of the Amplifier Modules with the data being clocked out serially from one channel to the next.



6.7 Diagram of one of the 5/10 channel amplifier modules

6.5.8 The 10 Channel Headbox

The 10 channel headbox is similar in construction and operation to the 5 channel. It comprises a Control Board, Electrode Board and Amplifier Modules that plug in to the Electrode Board.

The differences are that the Control Board in the ten channel version has additional sets of the filtering and Cross point switches. As these devices are all surface mounted it is impossible to upgrade a 5 channel to a 10 channel headbox.

Also there are five fully populated amplifier modules plugged into the Electrode board instead of two and a half .

Refer to descriptions and block diagrams given for the 5 channel version.

6.6 The Control Panel & Electrical Stimulators.

A schematic diagram for this unit is shown in Figure 6.8. This schematic diagram includes the Control panel with the control panel internal stim.

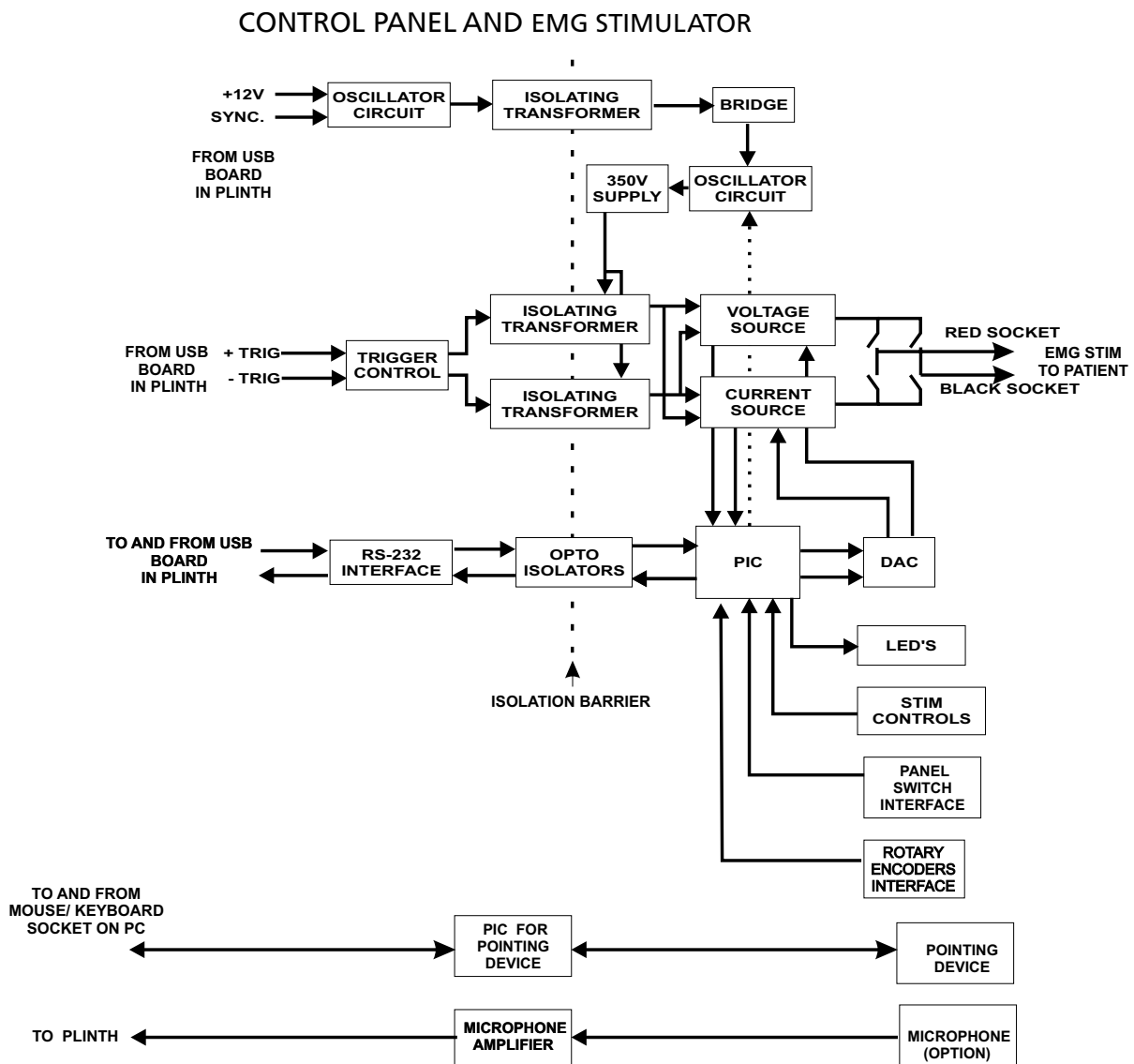
The Deluxe stimulator probe functions in a very similar way to the Control panel stimulator.

6.6.1 Control functions

A PIC micro-controller is used to monitor most of the control panel operations. Communication between the controller and the Plinth is made serially by an RS232 link. The USB board in the Plinth then communicates with the PC via the USB connection.

The PIC micro-controller also drives the "Acquire" and "Stim" LED's on the control panel at the appropriate times.

Control panel Pointing Device is has its own PIC micro-controller which then transmits this information to the PC mouse / keyboard connector.



6.8 control Panel and EMG Stimulator

The microphone input is has its own amplifier which then sends this signal to the Plinth.

The board is supplied with +12V, which is used to generate the isolated supplies for the stimulator and the control panel circuits.

6.6.2 Electrical Stimulator functions

The Control Panel electrical stimulator and the external Deluxe stimulator probe have almost identical circuits, and therefore this overview will cover both.

An oscillator circuit drives the primary of an isolating transformer, with a sync. signal from the PC ensuring that the stimulator isolated supply remains synchronised with the amplifier system.

The output from the isolating transformer is rectified and regulated to supply the d.c. supplies for the isolated side of the circuitry. A switching regulator and pump circuit generate a +350V supply for the stimulator output circuit which is only enabled when in EMG stimulating mode.

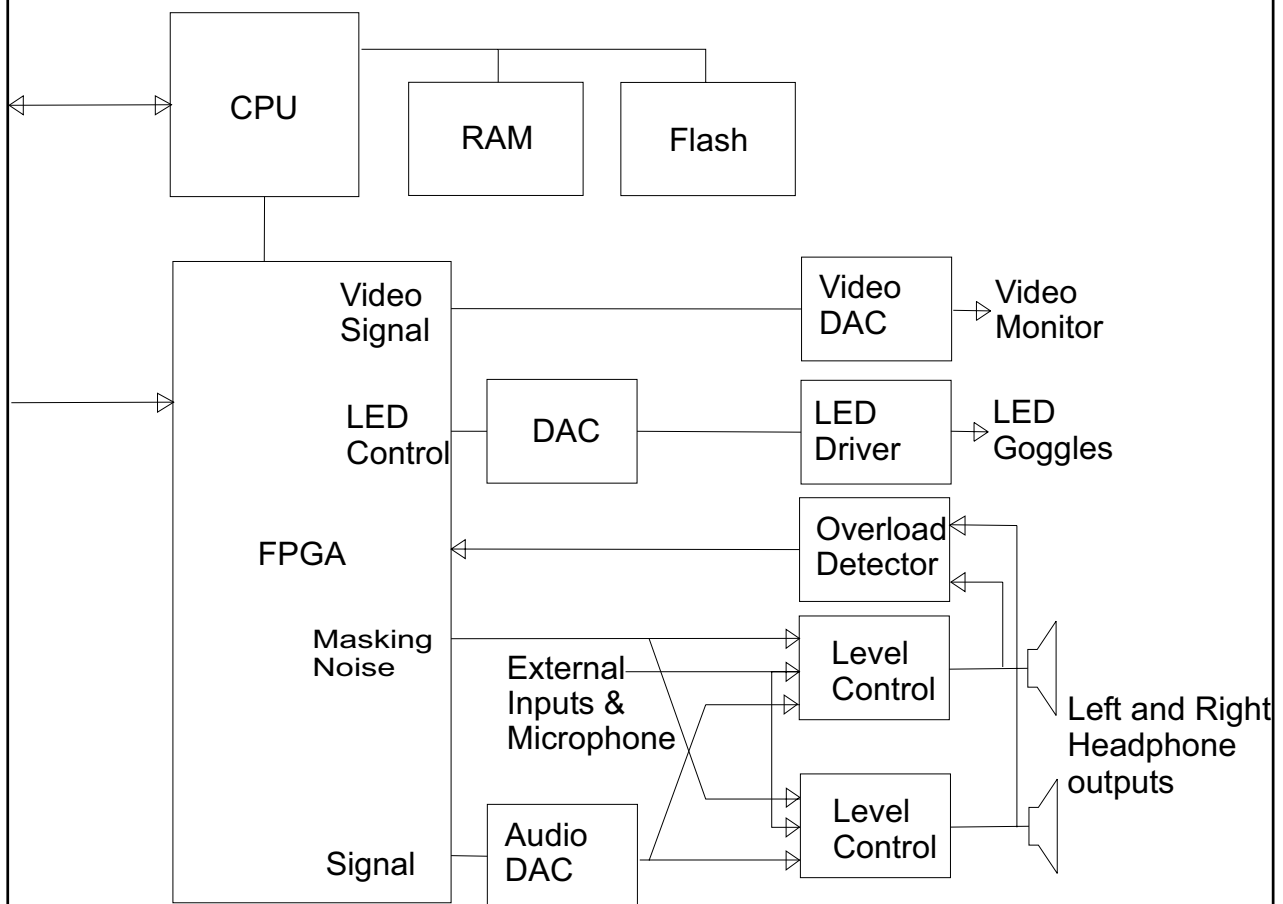
Control of the stimulator is via an RS-232 link through opto-isolators to a programmed PIC. The PIC sets up the stimulus driver circuits, by controlling the output of a dual DAC – one output for voltage, one output for current.

The direction of the stimulus pulse is selected by a positive or negative trigger signal from the USB board in the Plinth. The trigger pulse for the required polarity signal is input to the primary of an isolating transformer, and the output turns on the appropriate pair of FET switches to connect the relevant current or voltage controlled level to the patient Stimulator output sockets.

The delivered stimulus is monitored by the PIC, and if the pulse is incorrect, the PIC turns off the oscillator circuit providing the 350V supply and also discharges the supply. The PIC also sends an error message to the PC and user indicating an error has occurred. The stimulus will not start up again until the PIC is enabled by the PC.

The hand held stimulator probe has a stimulus intensity control built into it, and this control is connected directly to the PIC. The intensity level is returned to the PC, which sends the relevant signals back to the stimulator to set the required level. A pair of LED's on the probe indicate the polarity of the stimulus pulse by illuminating the LED adjacent to the positive electrode.

6.7 The EP Stimulator (Optional)



6.9 Diagram of the EP Audio and Visual stimulator (optional)

6.7.1 Overview of the EP board

The board contains circuits for the generation of auditory and visual stimuli.

6.7.2 CPU Section

A processor used contains two RS-232 compatible UARTs, a dual Direct Memory Access (DMA) controller, internal RAM (2k), a boot loader in internal ROM, a Memory Management Unit (MMU), four parallel I/O ports, an interrupt controller, two timers, an ADC.

The CPU interfaces to memory and I/O via a CPLD. This is programmed via the JTAG port connections on connector.

The memory device provide is a combined Flash(256k x 8) and SRAM(128k x 8) device.

Serial interfaces are shifted to RS-232 voltage levels by a quad comparator.

An FPGA implements most of the digital functions of the board. A space is provided for a second FPGA in case the circuit gets too large. If it were to be fitted, the functions would be partitioned between Auditory and Visual functions.

6.7.3 Auditory Stimulator

The FPGA generates digital waveforms which are loaded serially into the Audio DAC. The FPGA also generates the masking noise signal which is a digital Pseudo-random binary sequence (PRBS). The masking noise can be used unfiltered or filtered using the switched-capacitor filter chip as bandpass-filtered or notch-filtered. In the latter two cases one of three anti-alias filters is selected according to the filter clock frequency which is generated in the FPGA. Two circuits form low-pass post-filters to reject the clock frequency of the switched-capacitor filter chip. A chip selects the output of one of these filtered or the unfiltered broadband signal to be passed to the volume controls.

The Left and Right volume control devices are fed either the noise waveform output from the FPGA and DAC or the external signal input or the microphone input.

The volume control outputs are fed to the amplifier/attenuator circuits, which have a 0dB/-25dB input switch for noise and a +7dB/0dB/-25dB input switch for signal. The +7dB path is used only for high-intensity clicks. After passing through the amplifiers the signals follow one of three output paths: unattenuated; attenuated by 50dB or attenuated by 80dB.

The output voltages are monitored by the overload circuit. If an overload occurs the output amplifiers are shut down and a signal passes to the FPGA which generates an interrupt to the CPU. The overload circuit is adjusted by the octal DAC using levels determined during calibration.

There are also two inputs for feeding in external masking noise and audio signal from external sources.

6.7.4 Visual Stimulator

Digital video is generated within the FPGA and then passes to the Video triple DAC where it is converted to an analogue RGB video signal.

6.7.5 LED Goggle Interface

Two channels of the octal DAC control drive other devices which control the output currents to the LEDs. These currents are gated by the FPGA.

PATIENT SAFETY CHECKS FOR PIU SYSTEMS

Note the Plinth systems require different tests please turn to the next chapter.

In order to perform the following checks, a basic knowledge of Windows is required to verify the system settings.

The tests described in this chapter covers the currently available options for the Synergy Systems and therefore some tests or signal connections may not be relevant to the system being tested.

7.1 Equipment Required

Oscilloscope (CRO) – 100MHz Dual Channel
3k0 1%, 3k3 5%, 2k7 5% and 100Ω 1% loads
Signal Generator

A suitable **Electrical Safety Testing Instrument** for testing that the system meets the requirements of:-
EN60601-1 Type BF Applied Parts

UL2601-1 Type BF Applied Parts

CSA C22.2 No.601-1-M90 Type BF Applied Parts

EN60601-1-1

7.2 Initial Checks for all Systems

To see system connections for your **Tower**, **Notebook** or **Suite** system see the relevant diagram in chapter 4.

After connecting the system as shown in the appropriate diagram, connect the Synergy systems mains inlet to the mains supply and switch on using the power switch on the PC. Check that after the power on system test (POST), the Windows logo is displayed in the centre of the display. After a short period, the display should show the Windows desktop. The Synergy Systems application is launched automatically at start-up, initially showing the Synergy logo and then showing the "Synergy" screen similar to that shown in Figure 7-1.

The actual screen displayed is dependent on the version of software installed.

Verify that by moving the mouse around, the mouse pointer can be moved to all areas of the display. When the mouse is at one edge of the display the task bar will appear. The default edge is the bottom, but this can be changed by the user.

If necessary, adjust the display for optimum display brightness and contrast. You may need to refer to the monitor or Notebook PC manufacturers user manual.

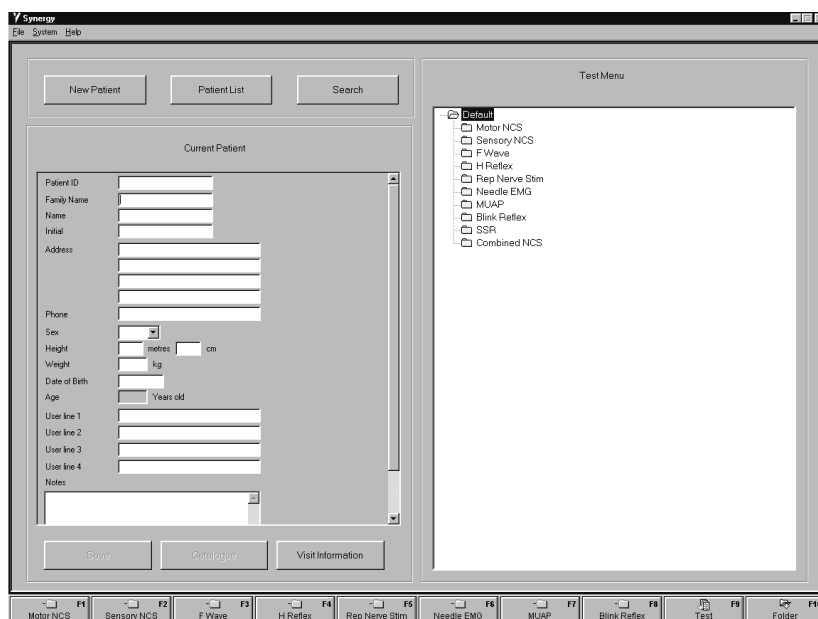


Figure 7-1 The initial "Main Application" screen

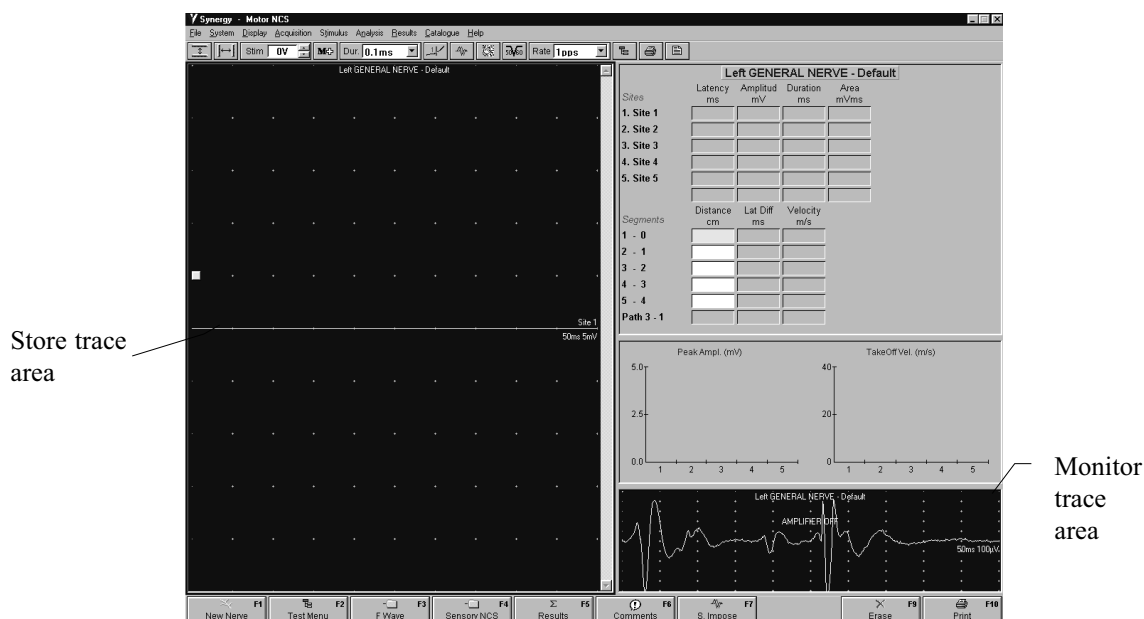


Figure 7-2 A typical "single channel" acquisition screen

7.3 Signal Input Checks for all Systems

From the test menu, select the "Motor NCS" test in the list by double-clicking on it, and then click on **OK** when the "Select Protocol" box is displayed. The display will now change to show the acquisition screen.

A typical screen is shown in figure 7.2, although there may be some variation according to how the user has configured the test. From the "Acquisition" drop-down menu, select "Setup" and turn on all amplifier channels. Click on **OK** and check that all monitor traces now show mains pick-up.

7.4 Internal EMG Stimulus Output checks for all Systems

If you have a stimulus probe connected then quit the Synergy application, it is not necessary to shut down Windows, now remove the probe. Restart the Synergy application.

From the "Stimulus" drop down menu select "Electrical Stim Setup" (see Figure 7.3).

Set the **Stim Type** to "Single" and Stimulator to **Stim A**. If necessary, set the **Output** to Voltage and the **Range** to High. Click on **OK** to return to the acquisition screen.

Connect a 3k3 resistor between the Stim A output sockets and monitor across the load with the oscilloscope.

Press the "stimulus" button on the Patient Interface Unit and check that the adjacent LED illuminates. Rotate the intensity control

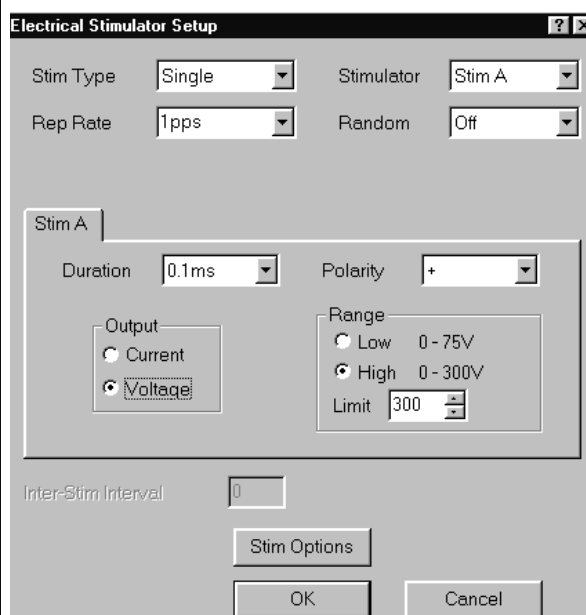


Figure 7-3 The EMG Stimulus setup control

on the Patient Interface Unit, and check on the oscilloscope for a positive going stimulus pulse at the selected duration and repetition rate with the amplitude as indicated at the top of the screen.

Press "stimulus" to turn off the stimulator check there is no output. Quit the application.

7.4.1 External EMG Stimulus Probe Output checks for all Systems (if required)

If an optional external Stim Probe is to be used connect it to the PIU and Transfer the 3k3 load and oscilloscope probe output sockets. The Synergy application must be restarted to detect the probe. Check that the positive polarity LED is illuminated. From the "Stimulus" drop down menu select "Electrical Stim Setup" (see Figure 7.3). Set the **Stim Type** to "Single" and Stimulator to **Stim B**. If necessary, set the **Output** to Voltage and the **Range** to High. Click on **OK** to return to the acquisition screen. Press the "stimulus" button on the stim probe and check that the adjacent LED illuminates. Rotate the intensity control on the probe, and check on the oscilloscope for a stimulus pulse at the selected duration and repetition rate with the amplitude as indicated at the top of the screen. Press "stimulus" on the probe to turn off the stimulator check there is no output. Quit the application and shut down Windows. Disconnect the Deluxe Stimulator Probe.

This is the end of the initial checks which are common to all systems. Now continue with the electrical Safety tests for your particular system.

For Notebook System
Electrical Safety Tests Continue on with Sections 7.5.0 to 7.12.0 inclusive

For Tower System Electrical Safety Tests skip forward to Sections 7.13.0 to 5.21.0 inclusive

For Suite System Electrical Safety Tests both of the above tests should be carried out as the Suite may be configured and used in two ways.
The patient applied PIU will therefore be tested connected to the Notebook PC and to the Tower.

7.5 Notebook System Electrical Safety Tests

Sections 7.5.0 to 7.12.0 inc

Electrical Leakage Current Tests

To carry out these tests correctly, an appropriate **Electrical Safety Testing Instrument** is required. This instrument should be able to check that the current limits quoted in the following sections are not exceeded. The current limits quoted are taken from EN-60601-1, UL2601-1 and CSA C22.2 No.601-1-M90 Type BF Applied Parts.

The following current measurements must be made with the Electrical Safety Testing Instrument and then re-testing while various fault conditions are simulated.

Earth leakage current

Enclosure leakage current

Patient leakage current

Patient Auxiliary current

When performing these checks using the Electrical Safety Testing Instrument, observe the following rules :-

- ♦ In tests where the unit is powered up, launch the test application before taking current readings to ensure that the EMG HT supplies are enabled. **DO NOT PRESS "STIM" DURING THESE TESTS, OTHERWISE YOU WILL GET A FALSE READING!**
- ♦ Where required to "switch the unit off", or to interrupt the mains supply or alter the "mains Line and Neutral connections", **quit the Synergy application and shut down Windows in the correct sequence before powering down to ensure system stability.** However, if the system is switched off prematurely, Windows should still "boot up" correctly the next time the system is switched on.
- ♦ When testing a **Notebook** system- Connect both the Notebook PC Power Supply and the Synergy Power Supply to the "Unit under test" socket on your Electrical Safety Testing Instrument.

The following safety checks are performed in sequence per test type. In order to save test time where Windows is repeatedly started and then shut down, it is possible to change the sequence of testing so that all tests with normal mains are performed first, followed by tests with reversed mains, and then the tests with open supply. It is up to the service engineer to decide on the sequence to be used, as long as all safety tests are performed.

Before testing begins links are required to short together all touchproof amplifier input sockets on the Patient Interface Unit

Links are also required to Short together both internal Stimulator output sockets.

Note:-As the type EMG stimulator in use determines the powering up of the stimulator circuits, please pay attention to any instructions on connection of selection of the Internal or External Stimulators. This should ensure complete testing.

For the Internal Stimulator to be used, you must Close down the Synergy Application and unplug the Deluxe Stimulator Probe (if present) from the "🔌" connector in to the Patient Interface Unit. Then restart the Synergy Application and select Stim **A** from the stim setup. The Internal Stimulator should then be functional.

7.5.1 Earth leakage - Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Earth Leakage Current.

Connect the Synergy Notebook system as instructed to measure the current in the protective earth lead. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4

Check that the measured Earth Leakage Current does not exceed 500µA a.c. (300µA a.c. in USA).

Repeat the above test with the mains Line and Neutral connections reversed. Remember to quit the Synergy application and shut down Windows in the correct sequence before powering down. This must be done each time the mains supply is interrupted.

Check that the measured Earth Leakage Current with the mains Line and Neutral connections reversed, does not exceed 500µA a.c. (300µA a.c. in USA).

7.5.2 Earth leakage Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Earth Leakage Current Single fault condition (Open Supply).

Connect the Synergy Notebook system as instructed to measure this current. Do not switch on the notebook PC. As the unit is un-powered the setup in section 7.4 is not required.

Check that the measured Earth Leakage Current Single fault condition (Open Supply) does not exceed 1000 μ A a.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy Systems.

7.6 Enclosure leakage current - Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c or DC Enclosure Leakage Current.

Connect the Synergy Notebook system as instructed to measure the enclosure leakage current. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage current from the rear metal panel of the Notebook PC and from the connector securing points on the panel of the PIU. Check that the enclosure current measured at these metal parts does not exceed 100 μ A a.c and 100 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Remember to quit the Synergy application and shut down Windows in the correct sequence before powering down. This must be done each time the mains supply is interrupted.

Check that the measured Enclosure Leakage Current with the mains Line and Neutral connections reversed, does not exceed 100 μ A a.c and 100 μ A d.c..

7.6.1 Enclosure leakage current Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Enclosure leakage current Single fault condition (Open Supply).

Connect the Synergy Notebook system as instructed to measure this current. Do not switch on the notebook PC. As the unit is un-powered the setup in section 7.4 is not required.

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage current from the rear metal panel of the Notebook PC and from the connector securing points on the panel of the PIU. Check that the enclosure current Single fault condition (Open Supply) measured at these metal parts does not exceed 500 μ A a.c and 500 μ A d.c..

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy system.

7.6.2 Enclosure leakage current Single Fault Condition – Protective Earth Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Enclosure leakage current Single fault condition (Protective Earth Open).

Connect the Synergy Notebook system as instructed to measure this current. Do not switch on the notebook PC. As the unit is un-powered the setup in section 7.4 is not required.

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage current from the rear metal panel of the Notebook PC and from the connector securing points on the panel of the PIU. Check that the enclosure current Single fault condition (Protective Earth Open) measured at these metal parts does not exceed 500 μ A a.c and 500 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy Systems

7.7 Patient Leakage Current Tests

7.7.1 Patient Leakage Current Tests (From Patient amplifiers)-Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current (Normal condition).

You will need to make a measurement connection from the Electrical Safety Testing Instrument to all the shorted together amplifier input sockets.

Connect the Synergy Notebook system as instructed to measure this current. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4.

Check that the Patient Leakage current (From Patient amplifiers) does not exceed 100 μ A a.c. and 10 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.7.2 Patient Leakage Current Tests (From Patient Stimulators)-Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current (Normal condition).

You will need to make a measurement connection from the Electrical Safety Testing Instrument to the shorted together stimulator sockets.

Check that the Patient Leakage current (From Patient stimulator sockets) does not exceed 100 μ A a.c. and 10 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.7.3 Patient Leakage Current Tests (From Patient amplifiers)-Single fault condition (Open Earth)

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current - Single fault condition (Open Earth)

You will need to make a measurement connection from the Electrical Safety Testing Instrument to all the shorted together amplifier input sockets.

Connect the Synergy Notebook system as instructed to measure this current. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4.

Check that the Patient Leakage current (From Patient amplifiers) does not exceed 500 μ A a.c. and 50 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.7.4 Patient Leakage Current Tests (From Patient Stimulators)-Single fault condition (Open Earth)

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current - Single fault condition (Open Earth)

You will need to make a measurement connection from the Electrical Safety Testing Instrument to all the shorted together Stimulator sockets.

Connect the Synergy Notebook system as instructed to measure this current. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4.

Check that the Patient Leakage current (From Patient Stimulator) does not exceed 500 μ A a.c. and 50 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.7.5 Patient Leakage Current Tests (From Patient amplifiers) Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current - Single fault condition (Open supply)

You will need to make a measurement connection from the Electrical Safety Testing Instrument to all the shorted together amplifier input sockets.

Connect the Synergy Notebook system as instructed to measure this current. Do not switch on the notebook PC. As the unit is un-powered the setup in section 7.4 is not required.

Check that the Patient Leakage current (From Patient amplifiers) Single fault condition (Open supply) does not exceed 500 μ A a.c. and 50 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.7.6 Patient Leakage Current Tests (From Patient Stimulators) Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current - Single fault condition (Open supply)

You will need to make a measurement connection from the Electrical Safety Testing Instrument to all the shorted together Stimulator sockets.

Connect the Synergy Notebook system as instructed to measure this current. Do not switch on the notebook PC. As the unit un-powered the setup in section 7.4 is not required.

Check that the Patient Leakage current (From Patient Stimulators) Single fault condition (Open supply) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.8 Patient Leakage Current Tests for External EMG Stimulator Probe

If the **External EMG Stimulator Probe** is supplied, then the some of the previous tests must be repeated.

You will need to make a measurement connection from the Electrical Safety Testing Instrument to both Stimulator Probe sockets shorted together.

For the Stimulator Probe to be used, you must Close down the Synergy Application and plug the Deluxe Stimulator Probe into the “” connector in to the Patient Interface Unit. Then restart the he Synergy Application and select **Stim B** from the stim setup. The Stimulator probe should then be functional.

DO NOT PRESS “STIM” DURING THESE TESTS, OTHERWISE YOU WILL GET A FALSE READING!

Repeat previous **tests 7.7.2, 7.7.4 and 7.7.6 with External EMG Stimulator Probe.**

7.9 Patient Auxiliary Current (Patient Amplifier inputs and Internal Stimulator)

Note:-If the Deluxe Stimulator Probe has been in use, you must close down the Synergy Application and un-plug the Deluxe Stimulator Probe from the PIU. Then restart the Synergy Application and select Stim A from the stim setup. The Internal Stimulator should then be functional. Do not press STIM.

Note: Patient Auxiliary currents must be measured between any single patient connection and all other patient connections connected together. All the amplifier and internal stimulator connections must be included in these Auxiliary current tests.

7.9.1 Patient Auxiliary Current-Normal Condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Normal condition.

Connect the Synergy Notebook system as instructed to measure this current. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4 Select **Stim A** from the stim setup.

Measure the Patient Auxiliary Current between **the first single patient connection** and **all other patient connections connected together.**

Check that the current does not exceed 100µA a.c. and 10µA d.c.

Select **the second single patient connection, join the first single patient connection to all other patient connections connected together.**

Check that the current does not exceed 100µA a.c. and 10µA d.c.

Continue as above until **all patient connections have been tested** and none have a current that exceeds 100µA a.c. and 10µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Switch off the unit.

7.9.2 Patient Auxiliary Current Leakage Current Single Fault Condition – Earth Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Earth Open.

Connect the Synergy Notebook system as instructed to measure this current. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4. Select **Stim A** from the stim setup.

Repeat the sequence of testing in 7.9.1 measuring that the current between any single patient connection and all other patient connections connected together does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.9.3 Patient Auxiliary Current Leakage Current Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Supply Open.

Connect the Synergy Notebook system as instructed to measure this current. Do not switch on the notebook PC. As the unit is un-powered the setup in section 7.4 is not required.

Repeat the sequence of testing in 7.9.1 measuring that the current between any single patient connection and all other patient connections connected together does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.10 Patient Auxiliary Current (Patient Amplifier inputs and External Stim Probe)

For the Stimulator Probe to be used, you must Close down the Synergy Application and plug the Deluxe Stimulator Probe into the "⚡" connector of the Patient Interface Unit. Then restart the Synergy Application and select **Stim B** from the stim setup. The Stimulator probe should then be functional.

Do not press STIM.

Note: Patient Auxiliary currents must be measured between any single patient connection and all other patient connections connected together. All the amplifier, internal stimulator and the Deluxe Stimulator Probe connections must be included in these Auxiliary current tests.

Repeat previous tests 7.9.1, 7.9.2 and 7.9.3 with External EMG Stimulator Probe.

Close down the application and switch off using the power switch on the notebook PC. Disconnect the Electrical Safety Testing Instrument.

Remove all the connections used to test the patient applied parts.

Connect the unit directly to the mains supply, switch on and wait for Windows to "boot up".

7.11 Safety Checks EMG Internal Stimulator

The tests in this section should be performed on both the PIU Internal Stimulator and Deluxe Stimulator Probe (if fitted).

Begin testing with the Deluxe Stimulator Probe disconnected. Switch on using the power switch on the notebook PC. When the Synergy application screen appears set it up as in section 7.4. Select **Stim A** from the stim setup.

7.11.1 Stimulus Fail Condition (Current Mode)

From the "Stimulus" drop down menu select "Electrical Stim Setup" (see figure 7.3). Set the **Output** to Current and the **Range** to High. Click on **OK** to return to the acquisition screen.

Connect the 3k3 load across the stimulus output connectors. Monitor across the load with the oscilloscope, connecting the probe earth lead to the black connector.

Using the control panel controls, set the **Duration** to 500µs and **Rep Rate** to 5pps. Set the stimulus level to 100mA.

Press **STIM** to turn on the stimulus, and check that a "Stim Fail Condition" error message is repeatedly displayed.

Set the stimulus level to 0mA, and check that the error message stops reappearing.

Press **STIM** to turn the stimulus off.

7.11.2 Overcurrent Checks

Set the **Output** to Voltage and the **Range** to High.

Replace the 3k3 stimulus load with the 100Ω stimulus load and monitor across it with the oscilloscope as before. Increase the stimulus level to 300V. Press **STIM** again and check that the stimulus pulse displayed on the oscilloscope is now 10V±1V.

Press **STIM** to turn the stimulus off.

7.11.3 Stimulus Fail Condition (Voltage Mode)

Connect the 2k7 load across the stimulus output connectors and monitor across it with the oscilloscope. Set the stimulus level to 300V.

Press **STIM** to turn on the stimulus, and check that a "Stim Fail Condition" error message is repeatedly displayed.

Set the stimulus level to 0V, and check that the error message stops reappearing. Press **STIM** to turn the stimulus off.

7.11.4 Mark/Space Failure

Connect the 3k0 stimulus load across the stimulus output sockets and monitor across it with the oscilloscope. Set the stimulus level to 50V and press **STIM**. Set the **Repetition Rate** to 5pps and increase the **Duration** in stages.

Check that when the pulse duration is 500µs, the stimulus pulse amplitude displayed on the oscilloscope immediately falls to 0V, and a "Mark/Space Shutdown" error message is displayed. If testing a stimulator probe, check that both the polarity LEDs are now off, this shows that shutdown has occurred.

7.12 Safety Checks EMG External Stimulator Probe.

The tests in this section should be performed on the External Stim probe (if fitted).

Note:-For the probe to be detected, you must Close down the Synergy Application and plug the Stimulator Probe into the "🔌" connector on the Patient Interface Unit. Then restart the Synergy Application and select **Stim B** from the stim setup. The probe should then be functional.

Repeat previous tests **7.11.1, 7.11.2, 7.11.3 and 7.10.4 with External EMG Stimulator Probe.**

Close the Synergy Systems application and then shut down Windows. Switch off the unit and disconnect all test equipment.

This is the end of the Electrical Safety Tests for the Notebook PIU System.

7.13 Tower System Electrical Safety Tests

Sections 7.13.0 to 7.21.0 inc

7.14 Earth bonding Tests

To carry out these tests correctly, an appropriate **Electrical Safety Testing Instrument** is required. This instrument should be able to check that the Earth connection of exposed metal parts is within the limits quoted in the following sections are not exceeded. The limits quoted are taken from EN60601-1, UL2601-1 and CSA C22.2 No.601-1-M90 Type BF Applied Parts.

Follow the instructions supplied with your **Electrical Safety Testing Instrument** to setup and measure Earth Bonding.

Connect the Tower system mains lead to the **Unit Under Test (UUT)** socket of the safety tester and disconnect the other end of the mains lead from the ISO-800. Connect the Electrical Safety Testing Instrument probe to the earth pin in the socket of the mains lead. Select "Earth Continuity Test" on the Electrical Safety Testing Instrument. Now begin the test and adjust the ohms reading to zero.

Stop testing and connect the mains lead to the ISO-800.

7.14.1 Earth Bonding Testing

Using the Electrical Safety Testing Instrument probe, measure the earth continuity between the mains Earth input lead to the ISO-800 and all exposed metalwork on the ISO-800, PC and any other options.

Select begin the test and continue to test for **5 seconds** each time.

Check that it is **<0.1Ω** at all points.

Electrical Leakage Current Tests

To carry out these tests correctly, an appropriate **Electrical Safety Testing Instrument** is required. This instrument should be able to check that the currents limits quoted in the following sections are not exceeded. The currents limits quoted are taken from EN-60601-1, UL2601-1 and CSA C22.2 No.601-1-M90 Type BF Applied Parts.

The following current measurements must be made with the Electrical Safety Testing Instrument and then re-testing while various fault conditions are simulated.

Earth leakage current

Enclosure leakage current

Patient leakage current

Patient Auxiliary current

When performing these checks using the Electrical Safety Testing Instrument, observe the following rules :-

- ♦ In tests where the unit is powered up, launch the test application before taking current readings to ensure that the EMG HT supplies are enabled. **DO NOT PRESS "STIM" DURING THESE TESTS, OTHERWISE YOU WILL GET A FALSE READING!**
- ♦ Where required to "switch the unit off", or to interrupt the mains supply or alter the "mains Line and Neutral connections", **quit the Synergy application and shut down Windows in the correct sequence before powering down to ensure system stability.** However, if the system is switched off prematurely, Windows should still "boot up" correctly the next time the system is switched on.
- ♦ When testing a **Tower** system- Connect the system as shown and then connect the mains input to the Isolating Transformer to the "Unit under test" socket on your Electrical Safety Testing Instrument.

The following safety checks are performed in sequence per test type. In order to save test time where Windows is repeatedly started and then shut down, it is possible to change the sequence of testing so that all tests with normal mains are performed first, followed by tests with reversed mains, and then the tests with open supply. It is up to the service engineer to decide on the sequence to be used, as long as all safety tests are performed.

Before testing begins links are required to short together all touchproof amplifier input sockets on the Patient Interface Unit

Links are also required to short together both internal Stimulator output sockets.

Note:-As the type of EMG stimulator in use determines the powering up of the stimulator circuits, please pay attention to any instructions on connection of selection of the Internal or External Stimulators. This should ensure complete testing.

For the Internal Stimulator to be used, you must close down the Synergy Application and unplug the Deluxe Stimulator Probe (if present) from the "🔌" connector on the Patient Interface Unit. Then restart the Synergy Application and select Stim A from the stim setup. The Internal Stimulator should then be functional.

7.14.2 Earth leakage - Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Earth Leakage Current.

Connect the Synergy Tower system as instructed to measure the current in the protective earth lead. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4

Check that the measured Earth Leakage Current does not exceed 500µA a.c. (300µA a.c. in USA).

Repeat the above test with the mains Line and Neutral connections reversed.
Remember to quit the Synergy application and shut down Windows in the correct sequence before powering down. This must be done each time the mains supply is interrupted.
Check that the measured Earth Leakage Current with the mains Line and Neutral connections reversed, does not exceed 500µA a.c. (300µA a.c. in USA).

7.14.3 Earth leakage Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Earth Leakage Current Single fault condition (Open Supply).

Connect the Synergy Tower system as instructed to measure this current. Do not switch on the Tower PC. As the unit is un-powered the setup in section 7.4 is not required.

Check that the measured Earth Leakage Current Single fault condition (Open Supply) does not exceed 1000µA a.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy Systems.

7.15 Enclosure leakage current - Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c or d.c. Enclosure Leakage Current.

Connect the Synergy Tower system as instructed to measure the enclosure leakage current. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage from the rear metal panel of the Tower PC, the Equipotential Terminal on the ISO800 Isolating Transformer and from the connector securing points on the panel of the PIU. Check that the enclosure current measured at these metal parts does not exceed 100µA a.c and 100µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.
Remember to quit the Synergy application and shut down Windows in the correct sequence before powering down. This must be done each time the mains supply is interrupted.

Check that the measured Enclosure Leakage Current with the mains Line and Neutral connections reversed, does not exceed 100µA a.c and 100µA d.c..

7.15.1 Enclosure leakage current Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Enclosure leakage current in single fault condition (Open Supply).

Connect the Synergy Tower system as instructed to measure this current. Do not switch on the Tower PC. As the unit is un-powered the setup in section 7.4 is not required.

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage from the rear metal panel of the Tower PC, the Equipotential Terminal on the ISO800 Isolating Transformer and from the connector securing points on the panel of the PIU. Check that the enclosure current Single fault condition (Open Supply) measured at these metal parts at the does not exceed 500 μ A a.c and 500 μ A d.c..

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy system.

7.15.2 Enclosure leakage current Single Fault Condition – Protective Earth Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Enclosure leakage current in single fault condition (Protective Earth Open).

Connect the Synergy Tower system as instructed to measure this current. Do not switch on the Tower PC. As the unit is un-powered the setup in section 7.4 is not required.

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage from the rear metal panel of the Tower PC, the Equipotential Terminal on the ISO800 Isolating Transformer and from the connector securing points on the panel of the PIU. Check that the enclosure current in single fault condition (Protective Earth Open) measured at these metal parts at the does not exceed 500 μ A a.c and 500 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy Systems

7.16 Patient Leakage Current Tests

7.16.1 Patient Leakage Current Tests (From Patient amplifiers)-Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current (Normal condition).

You will need to connect (short) together all of the amplifier input sockets.

The Patient Leakage current measurement for the Amplifiers must be made from this point formed where all of the amplifier input sockets are shorted together.

Connect the Synergy Tower system as instructed to measure this current. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4.

Check that the Patient Leakage current (From Patient amplifiers) does not exceed 100 μ A a.c. and 10 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.16.2 Patient Leakage Current Tests (From Patient Stimulators)-Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current (Normal condition).

You will need to make a measurement connection from the Electrical Safety Testing Instrument to the shorted together stimulator sockets.

Check that the Patient Leakage current (From Patient stimulator sockets) does not exceed 100 μ A a.c. and 10 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.16.3 Patient Leakage Current Tests (From Patient amplifiers)-Single fault condition (Open Earth)

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open Earth)

The Patient Leakage current measurement for the Amplifiers must be made from the point formed where all of the amplifier input sockets are shorted together.

Connect the Synergy Tower system as instructed to measure this current. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4.

Check that the Patient Leakage current (From Patient amplifiers) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.16.4 Patient Leakage Current Tests (From Patient Stimulators)-Single fault condition (Open Earth)

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open Earth)

You will need to make a measurement connection from the Electrical Safety Testing Instrument to all the shorted together Stimulator sockets.

Connect the Synergy Tower system as instructed to measure this current. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4.

Check that the Patient Leakage current (From Patient Stimulator) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.16.5 Patient Leakage Current Tests (From Patient amplifiers) Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open supply)

The Patient Leakage current measurement for the Amplifiers must be made from the point formed where all of the amplifier input sockets are shorted together.

Connect the Synergy Tower system as instructed to measure this current. Do not switch on the Tower PC. As the unit is un-powered the setup in section 7.4 is not required.

Check that the Patient Leakage current (From Patient amplifiers) Single fault condition (Open supply) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.16.6 Patient Leakage Current Tests (From Patient Stimulators) Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open supply)

The Patient Leakage current measurement for the Stimulator must be made from the point formed where all of the Stimulators output sockets are shorted together.

Connect the Synergy Tower system as instructed to measure this current. Do not switch on the Tower PC. As the unit un-powered the setup in section 7.4 is not required.

Check that the Patient Leakage current (From Patient Stimulators) Single fault condition (Open supply) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.17 Patient Leakage Current Tests for External EMG Stimulator Probe

If the **External EMG Stimulator Probe** is supplied, then the some of the previous tests must be repeated.

You will need to make a measurement connection from the Electrical Safety Testing Instrument to both Stimulator Probe sockets shorted together.

For the Stimulator Probe to be used, you must Close down the Synergy Application and plug the Deluxe Stimulator Probe into the "🔌" connector in to the Patient Interface Unit. Then restart the Synergy Application and select **Stim B** from the stim setup. The Stimulator probe should then be functional.

DO NOT PRESS "STIM" DURING THESE TESTS, OTHERWISE YOU WILL GET A FALSE READING!

Repeat previous **tests 7.16.2, 7.16.4 and 7.16.6 with External EMG Stimulator Probe.**

7.18 Patient Auxiliary Current (Patient Amplifier inputs and Internal Stimulator)

Note:-For the Internal Stimulator to be used, you must close down the Synergy Application and unplug the Deluxe Stimulator Probe (if present) from the "🔌" connector on the Patient Interface Unit. Then restart the Synergy Application and select Stim A from the stim setup. The Internal Stimulator should then be functional. Do not press STIM.

Note: Patient Auxiliary currents must be measured between any single patient connection and all other patient connections connected together. All the amplifier and internal stimulator connections must be included in these Auxiliary current tests.

7.18.1 Patient Auxiliary Current-Normal Condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Normal condition.

Connect the Synergy Tower system as instructed to measure this current. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4 Select **Stim A** from the stim setup.

Measured the Patient Auxiliary Current between **the first single patient connection** and **all other patient connections connected together.**

Check that the does not exceed 100µA a.c. and 10µA d.c.

Select **the second single patient connection**, **join the first single patient connection** to **all other patient connections connected together.**

Check that the current does not exceed 100µA a.c. and 10µA d.c.

Continue until every patient connection has been tested.

Check that the current does not exceed 100µA a.c. and 10µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Switch off the unit.

7.18.2 Patient Auxiliary Current Leakage Current Single Fault Condition – Earth Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Earth Open.

Connect the Synergy Tower system as instructed to measure this current. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4. Select **Stim A** from the stim setup.

Repeat the sequence of testing in **7.18.1** measuring that the current between any single patient connection and **all** other patient connections connected together does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.18.3 Patient Auxiliary Current Leakage Current Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Supply Open.

Connect the Synergy Tower system as instructed to measure this current. Do not switch on the Tower PC. As the unit un-powered the setup in section 7.4 is not required.

Repeat the sequence of testing in 7.18.1 measuring that the current between any single patient connection and **all** other patient connections connected together does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

7.19 Patient Auxiliary Current (Patient Amplifier inputs and External Stim Probe)

For the Stimulator Probe to be used, you must Close down the Synergy Application and plug the Deluxe Stimulator Probe into the "⚡" connector on the Patient Interface Unit. Then restart the Synergy Application and select **Stim B** from the stim setup. The Stimulator probe should then be functional.

Do not press STIM.

Note: Patient Auxiliary currents must be measured between any single patient connection and all other patient connections connected together. All the amplifier, internal stimulator and the Deluxe Stimulator Probe connections must be included in these Auxiliary current tests.

Repeat previous tests **7.18.1, 7.18.2 and 7.18.3 with External EMG Stimulator Probe.**

Close down the application and switch off using the power switch on the Tower PC. Disconnect the Electrical Safety Testing Instrument.

Remove all the connections used to test the patient applied parts.

Connect the unit directly to the mains supply, switch on and wait for Windows to "boot up".

7.20 Safety Checks EMG Stimulator

The tests in this section should be performed on both the PIU Internal Stimulator and Deluxe Stimulator Probe (if fitted).

Begin testing with the Deluxe Stimulator Probe disconnected. Switch on using the power switch on the Tower PC. When the Synergy application screen appears set it up as in section 7.4, Select **Stim A** from the stim setup.

7.20.1 Stimulus Fail Condition (Current Mode)

From the "Stimulus" drop down menu select "Electrical Stim Setup" (see figure 7.3). Set the **Output** to Current and the **Range** to High. Click on **OK** to return to the acquisition screen.

Connect the 3k3 load across the stimulus output connectors. Monitor across the load with the oscilloscope, connecting the probe earth lead to the black connector.

Using the control panel controls, set the **Duration** to 500µs and **Rep Rate** to 5pps. Set the stimulus level to 100mA.

Press **STIM** to turn on the stimulus, and check that a "Stim Fail Condition" error message is repeatedly displayed.

Set the stimulus level to 0mA, and check that the error message stops reappearing.

Press **STIM** to turn the stimulus off.

7.20.2 Over current Checks

Set the **Output** to Voltage and the **Range** to High.

Replace the 3k3 stimulus load with the 100Ω stimulus load and monitor across it with the oscilloscope as before. Increase the stimulus level to 300V. Press **STIM** again and check that the stimulus pulse displayed on the oscilloscope is now 10V±1V.

Press **STIM** to turn the stimulus off.

7.20.3 Stimulus Fail Condition (Voltage Mode)

Connect the 2k7 load across the stimulus output connectors and monitor across it with the oscilloscope. Set the stimulus level to 300V.

Press **STIM** to turn on the stimulus, and check that a "Stim Fail Condition" error message is repeatedly displayed.

Set the stimulus level to 0V, and check that the error message stops reappearing. Press **STIM** to turn the stimulus off.

7.20.4 Mark/Space Failure

Connect the 3k0 stimulus load across the stimulus output sockets and monitor across it with the oscilloscope. Set the stimulus level to 50V and press **STIM**. Set the **Repetition Rate** to 5pps and increase the **Duration** in stages.

Check that when the pulse duration is 500µs, the stimulus pulse amplitude displayed on the oscilloscope immediately falls to 0V, and a "Mark/Space Shutdown" error message is displayed. If testing a stimulator probe, check that both the polarity LEDs are now off, this shows that shutdown has occurred.

7.21 Safety Checks EMG External Stimulator Probe.

The tests in this section should be performed on the External Stim probe (if fitted).

Note:-For the probe to be detected, you must Close down the Synergy Application and plug the Stimulator Probe into the "" connector on the Patient Interface Unit. Then restart the Synergy Application and select **Stim B** from the stim setup. The probe should then be functional.

Repeat previous **tests 7.20.1, 7.20.2, 7.20.3 and 7.20.4 with External EMG Stimulator Probe.**

Close the Synergy Systems application and then shut down Windows. Switch off the unit and disconnect all test equipment.

This is the end of the Electrical Safety Tests for the Tower PIU System.

PATIENT SAFETY CHECKS FOR PLINTH SYSTEMS

Note the **PIU systems** require different tests please turn to the previous chapter.

In order to perform the following checks, a basic knowledge of Windows is required to verify the system settings.

The tests described in this chapter covers the currently available options for the Synergy Systems with **Plinth** and therefore some tests or signal connections may not be relevant to the system being tested.

All **Tower Plinth** systems must have the isolation transformer.

With **Notebook Plinth** systems the isolation transformer is optional. If used with the system it must be tested.

8.1 Equipment Required

Oscilloscope (CRO) – 100MHz Dual Channel
3k Ω 1%, 3k Ω 5%, 2k Ω 5% and 100 Ω 1% loads
Signal Generator

A suitable **Electrical Safety Testing Instrument** for testing that the system meets the requirements of:-
EN60601-1 Type BF Applied Parts

UL2601-1 Type BF Applied Parts

CSA C22.2 No.601-1-M90 Type BF Applied Parts

EN60601-1-1

8.2 Initial Checks for all Systems

To see system connections for your **Plinth Tower** or **Notebook** system see the relevant diagram in chapter 3.

After connecting the Plinth system as shown in the appropriate diagram, connect the Synergy systems mains inlet to the mains supply.

Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC.

Check that after the power on system test (POST), the Windows logo is displayed in the centre of the display. After a short period, the display should show the Windows desktop. The Synergy Systems application is launched automatically at start-up, initially showing the Synergy logo and then showing the "Synergy" screen similar to that shown in Figure 8.1

The actual screen displayed is dependent on the version of software installed.

With the **Tower** and **Notebook Plinth systems** verify that the pointing device on the control panel moves the on screen pointer to all areas of the display.

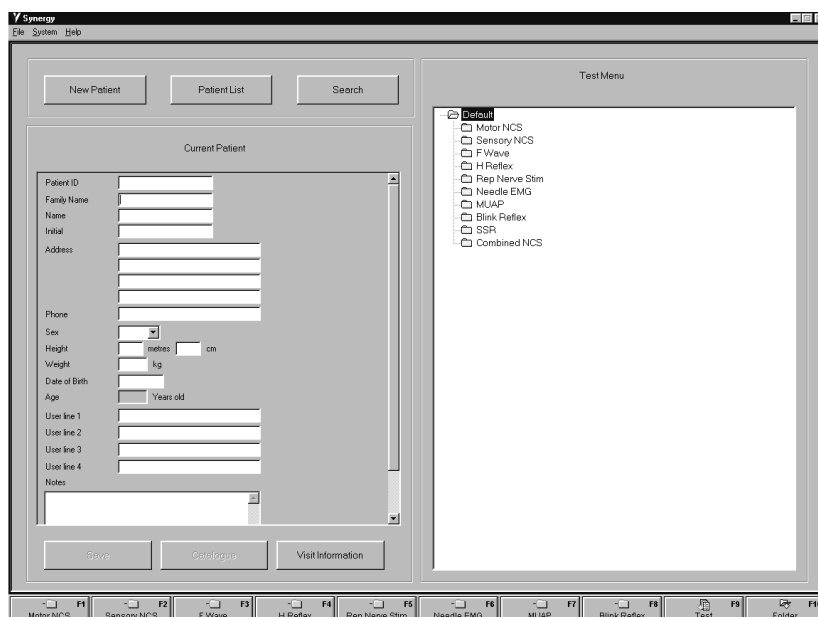


Figure 8-1 The initial "Main Application" screen

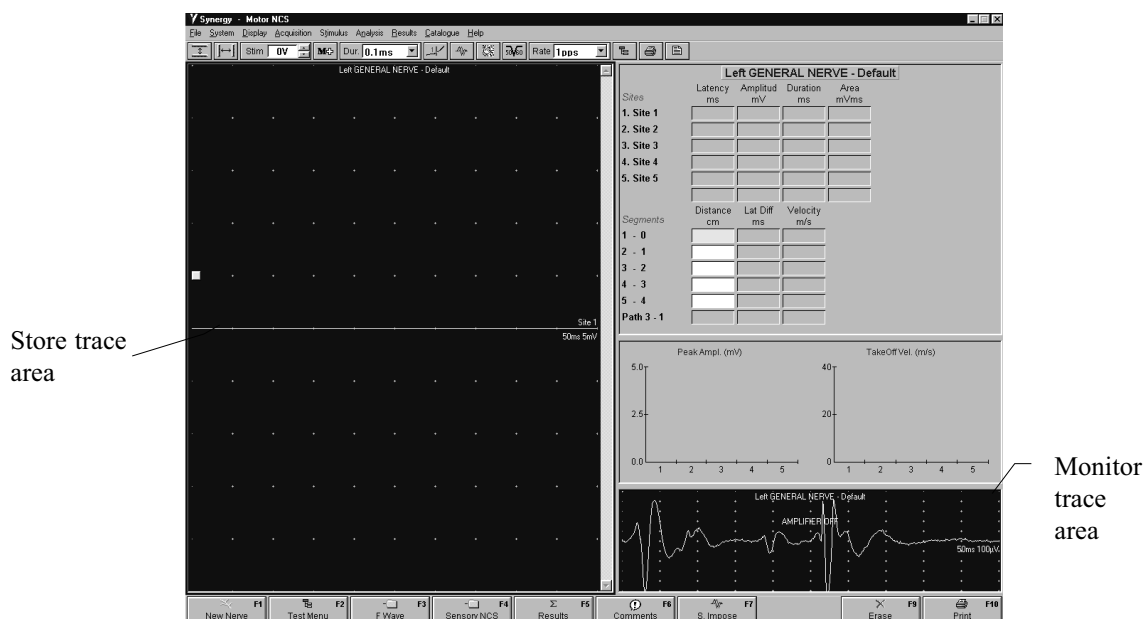


Figure 8-2 A typical "single channel" acquisition screen

With the **Notebook Plinth system** verify that the pointing device in the **Notebook PC** also moves the on screen pointer to all areas of the display. Optionally the **Tower or Notebook Plinth** systems can be controlled with a standard mouse plugged into the PC PS2 port. This can be used in place of the Control Panel Pointing Device but it is not possible to use both at once as there is only one connector.

Check when the on screen pointer is at one edge of the display the task bar will appear. The default edge is the bottom, but this can be changed by the user.

If necessary, adjust the display for optimum display brightness and contrast. You may need to refer to the monitor or Notebook PC manufacturers user manual.

8.3 Signal Input Checks for Plinth Systems

From the test menu, select the "Motor NCS" test in the list by double-clicking on it, and then click on **OK** when the "Select Protocol" box is displayed. The display will now change to show the acquisition screen.

A typical screen is shown in figure 8.2, although there may be some variation according to how the user has configured the test. From the "Acquisition" drop-down menu, select "Setup" and turn on all amplifier channels. Click on **OK** and check that all monitor traces now show mains pick-up.

8.4 Internal EMG Stimulus Output checks for Plinth Systems

If you have a stimulus probe connected then quit the Synergy application, it is not necessary to shut down Windows, now remove the probe. Restart the Synergy application.

From the "Stimulus" drop down menu select "Electrical Stim Setup" (see Figure 8.3).

Set the **Stim Type** to "Single" and Stimulator to **Sim A**. If necessary, set the **Output** to Voltage and the **Range** to High. Click on **OK** to return to the acquisition screen.

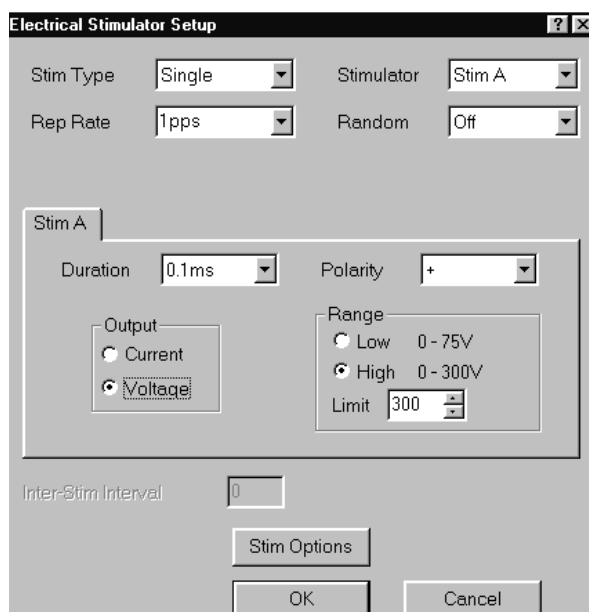


Figure 8-3 The EMG Stimulus setup control

Connect a 3k3 resistor between the **Stim output sockets** on the **Control Panel** and monitor across the load with the oscilloscope.

Press the "Stim On /Off" button on the Control Panel and check that the adjacent LED illuminates. Rotate the **Stim A intensity control** on the Control Panel, and check on the oscilloscope for a positive going stimulus pulse at the selected duration and repetition rate with the amplitude as indicated at the top of the screen.

Press "Stim On /Off" to turn off the stimulator check there is no output. Quit the application.

8.4.1 External EMG Stimulus Probe Output checks for all Systems (if required)

If an optional external Stim Probe is to be used connect it to the **Plinth stim B socket** and Transfer the 3k3 load and oscilloscope probe output sockets. The Synergy application must be restarted to detect the probe. Check that the positive polarity LED is illuminated. From the "Stimulus" drop down menu select "Electrical Stim Setup" (see Figure 8.3).

Set the **Stim Type** to "Single" and Stimulator to **Sim B**. If necessary, set the **Output** to Voltage and the **Range** to High. Click on **OK** to return to the acquisition screen. Press the "stimulus" button on the stim probe and check that the adjacent LED illuminates. Rotate the intensity control on the probe, and check on the oscilloscope for a stimulus pulse at the selected duration and repetition rate with the amplitude as indicated at the top of the screen. Also check that the **Stim B intensity control** on the **Control Panel** functions and varies the stimulus pulse with the **Stim B** amplitude indicated at the top of the screen.

8.4.2 If the system has 2 External EMG Stim Probes

If the system has 2 optional **external Stim Probes** then the previous set of checks can be repeated.

Connect the second probe to the **Plinth stim A socket**

Transfer the 3k3 load and oscilloscope probe output sockets. The Synergy application must be restarted to detect the probe.

Note the internal stimulator in the Control Panel will now be disabled.

Check that the positive polarity LED is illuminated. From the "Stimulus" drop down menu select "Electrical Stim Setup" (see Figure 8.3).

Set the **Stim Type** to "Single" and Stimulator to **Sim A**. If necessary, set the **Output** to Voltage and the **Range** to High. Click on **OK** to return to the acquisition screen. Press the "stimulus" button on the stim probe and check that the adjacent LED illuminates. Rotate the intensity control on the probe, and check on the oscilloscope for a stimulus pulse at the selected duration and repetition rate with the amplitude as indicated at the top of the screen. Also check that the **Stim A intensity control** on the **Control Panel** functions and varies the stimulus pulse with the **Stim A** amplitude indicated at the top of the screen.

Press "stimulus" on the probe to turn off the stimulator check there is no output. Quit the application and shut down Windows. Disconnect the second Deluxe Stimulator Probe.

8.4.3 EP Stim Checks

8.4.4 Visual Stimulus Checks

Plug the SVGA monitor into the visual EP Stim  connector on the right hand edge of the Plinth.

From the **Test Menu** select the appropriate **EP Tests folder**, then select the **VEP Pattern** test. From the **Stimulus / Stim. Setup ...** screen, set various **Pattern** types, **Sizes**, **Contrasts**, **Presentations**, **Masking** and **Fixation** size settings, each time clicking on **Ok** when set.

Check that the visual stimulus pattern displayed on the VGA monitor is correct for each setting.

Press the Control Panel **Stim.** button.

Check that the displayed pattern changes at the selected Rep. Rate.

Press **Stim.** on the Front Panel.

8.4.5 Audiometric Stimulus Checks

Plug the **Audiometric Headphone** set into the  connector on the right hand edge of the Plinth.

Click the **Test Menu** button and select the **CERA** test.

From the **Stimulus / Stim. Setup ...** screen check and if necessary set **Audio Type** to **Tone Burst**, **Intensity** to **100dB**, **Frequency** to **1kHz**. Turn **Masking On** and set **Side** to **Contralateral**, **Type** to **White Noise** and **Intensity** to **0dB**. Click on **Ok** when set.

Press the Control Panel **Stim.** button.

Check that a 1kHz tone at the set Rep. Rate can be heard from the left earphone and white noise in the right earphone.

Press the Control Panel **Stim.** button.

Click on the **Other Side** button and press the Control Panel **Stim.** button.

Check that a 1kHz tone can be heard from the right earphone and white noise in the left earphone.

Change **Masking** to **Narrow Band**. Select various **Frequencies**, **Intensities** and **Masking** levels.

Check that the frequency, and intensity of the tone and masking heard can be varied.

Click the **Test Menu** button and select the **BAER** test.

From the **Stimulus / Stim. Setup ...** screen check and if necessary set **Audio Type** to **Click**, **Intensity** to **100dB**, **Duration** to **0.1ms**. Turn **Masking On** and set **Side** to **Contralateral**, **Type** to **White Noise** and **Intensity** to **0dB**. Click on **Ok** when set.

Press the Control Panel **Stim.** button.

Check that a 'click' at the set Rep. Rate can be heard from the left earphone and white noise in the right earphone.

Press the Control Panel **Stim.** button.

Click on the **Other Side** button and press the Control Panel **Stim.** button. Set the stim. parameters as above.

Check that a 'click' can be heard from the right earphone and white noise in the left earphone.

Select various **Intensities** and **Masking** levels.

Check that the intensity of the 'click' and masking heard can be varied.

Close down the Synergy Systems application and then Windows. Switch off the system and disconnect all test equipment.

This is the end of the initial checks which are common to all systems. Now continue with the electrical Safety tests for your particular system.

8.5 Plinth System Electrical Safety Tests

Sections 8.13.0 to 8.21.0 inc

These tests cover both the Notebook and Tower Plinth syetms.

8.6 Earth bonding Tests

To carry out these tests correctly, an appropriate **Electrical Safety Testing Instrument** is required. This instrument should be able to check that the Earth connection of exposed metal parts is within the limits quoted in the following sections are not exceeded. The limits quoted are taken from EN60601-1, UL2601-1 and CSA C22.2 No.601-1-M90 Type BF Applied Parts.

Follow the instructions supplied with your **Electrical Safety Testing Instrument** to setup and measure Earth Bonding.

Connect the **Plinth** system mains lead to the **Unit Under Test** (UUT) socket of the safety tester and disconnect the other end of the mains lead from the ISO-800. Connect the Electrical Safety Testing Instrument probe to the earth pin in the socket of the mains lead. Select "Earth Continuity Test" on the Electrical Safety Testing Instrument. Now begin the test and adjust the ohms reading to zero.

Stop testing and connect the mains lead to the ISO-800.

8.6.1 Earth Bonding Testing

Using the Electrical Safety Testing Instrument probe, measure the earth continuity between the mains **Earth input lead to the system** and all exposed metalwork on the **Isolation Transformer** (if used), the **Plinth**, the **PC Tower** and any other Oxford Instruments **Approved mains powered options**.

Note If the system has a **Notebook** PC do not measure to metal parts of the Notebook PC.

Select begin the test and continue to test for **5 seconds** each time.

Check that it is **<0.1Ω** at all points.

Electrical Leakage Current Tests

To carry out these tests correctly, an appropriate **Electrical Safety Testing Instrument** is required. This instrument should be able to check that the currents limits quoted in the following sections are not exceeded. The currents limits quoted are taken from EN-60601-1, UL2601-1 and CSA C22.2 No.601-1-M90 Type BF Applied Parts.

The following current measurements must be made with the Electrical Safety Testing Instrument and then re-testing while various fault conditions are simulated.

Earth leakage current

Enclosure leakage current

Patient leakage current

Patient Auxiliary current

When performing these checks using the Electrical Safety Testing Instrument, observe the following rules :-

- ♦ In tests where the unit is powered up, launch the test application before taking current readings to ensure that the EMG HT supplies are enabled. **DO NOT PRESS "STIM" DURING THESE TESTS, OTHERWISE YOU WILL GET A FALSE READING!**
- ♦ Where required to "switch the unit off", or to interrupt the mains supply or alter the "mains Line and Neutral connections", **quit the Synergy application and shut down Windows in the correct sequence before powering down to ensure system stability.** However, if the system is switched off prematurely, Windows should still "boot up" correctly the next time the system is switched on.
- ♦ When testing a **Plinth** system- Connect the system as shown and then connect the mains input to the "Unit under test" socket on your Electrical Safety Testing Instrument. If the system has an Isolating Transformer this must be part of the system.

The following safety checks are performed in sequence per test type. In order to save test time where Windows is repeatedly started and then shut down, it is possible to change the sequence of testing so that all tests with normal mains are performed first, followed by tests with reversed mains, and then the tests with open supply. It is up to the service engineer to decide on the sequence to be used, as long as all safety tests are performed.

Before testing begins links are required to short together all touchproof amplifier input sockets on the Patient Interface Unit

Links are also required to short together both internal Stimulator output sockets.

Note:-As the type of EMG stimulator in use determines the powering up of the stimulator circuits, please pay attention to any instructions on connection of selection of the Internal or External Stimulators. This should ensure complete testing.

For the Internal Stimulator to be used, you must close down the Synergy Application and unplug the Deluxe Stimulator Probe (if present) from the "⚡" connector on the Patient Interface Unit. Then restart the Synergy Application and select Stim A from the stim setup. The Internal Stimulator should then be functional.

8.6.2 Earth leakage - Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Earth Leakage Current.

Connect the Synergy **Plinth** system as instructed to measure the current in the protective earth lead. Switch on the Isolation transformer (if used), the Plinth mains switch and the power switch on the PC. When the Synergy application screen appears set it up as in section 8.4.

Check that the measured Earth Leakage Current does not exceed 500µA a.c. (300µA a.c. in USA).

Repeat the above test with the mains Line and Neutral connections reversed. Remember to quit the Synergy application and shut down Windows in the correct sequence before powering down. This must be done each time the mains supply is interrupted.

Check that the measured Earth Leakage Current with the mains Line and Neutral connections reversed, does not exceed 500µA a.c. (300µA a.c. in USA).

8.6.3 Earth leakage Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Earth Leakage Current Single fault condition (Open Supply).

Connect the Synergy plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, Do not Switch on the power switch on the PC. As the unit is un-powered the setup in section 8.4 is not required.

Check that the measured Earth Leakage Current Single fault condition (Open Supply) does not exceed 1000 μ A a.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy Systems.

8.7 Enclosure leakage current - Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c.or d.c. Enclosure Leakage Current.

Connect the Synergy **Plinth** system as instructed to measure the enclosure leakage current. Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC. When the Synergy application screen appears set it up as in section 8.4.

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage from the rear metal panel of the PC, an exposed metal part on the Isolating Transformer(if used) and from the Earth (ground Functional) terminal on the Plinth. 

Check that the enclosure current measured at these metal parts does not exceed 100 μ A a.c and 100 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Remember to quit the Synergy application and shut down Windows in the correct sequence before powering down. This must be done each time the mains supply is interrupted.

Check that the measured Enclosure Leakage Current with the mains Line and Neutral connections reversed, does not exceed 100 μ A a.c and 100 μ A d.c..

8.7.1 Enclosure leakage current Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Enclosure leakage current in single fault condition (Open Supply).

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, Do not switch on the power switch on the PC. As the unit is un-powered the setup in section 8.4 is not required.

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage from the rear metal panel of the PC, an exposed metal part on the Isolating Transformer(if used) and from Earth (ground Functional) terminal on the Plinth. 

Check that the enclosure current Single fault condition (Open Supply) measured at these metal parts at the does not exceed 500 μ A a.c and 500 μ A d.c..

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy system.

8.7.2 Enclosure leakage current Single Fault Condition – Protective Earth Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure a.c. Enclosure leakage current in single fault condition (Protective Earth Open).

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, Do not switch on the power switch on the PC. As the unit is un-powered the setup in section 8.4 is not required.

With the test probe of the Electrical Safety Testing Instrument measure the Enclosure Leakage from the rear metal panel of the PC, an exposed metal part on the Isolating Transformer(if used) and from Earth (ground Functional) terminal on the Plinth. 

Check that the enclosure current in single fault condition (Protective Earth Open) measured at these metal parts at the does not exceed 500 μ A a.c and 500 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Turn off the mains supply to the Synergy Systems

8.8 Patient Leakage Current Tests

8.8.1 Patient Leakage Current Tests (From Patient amplifiers)-Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current (Normal condition).

You will need to connect (short) together together all of the amplifier input sockets.

The Patient Leakage current measurement for the Amplifiers must be made from this point formed where all of the amplifier input sockets are shorted together.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC.

When the Synergy application screen appears set it up as in section 8.4.

Check that the Patient Leakage current (From Patient amplifiers) does not exceed 100 μ A a.c. and 10 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.8.2 Patient Leakage Current Tests (From Patient Stimulators)-Normal condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current (Normal condition).

You will need to make a measurement connection from the Electrical Safety Testing Instrument to the shorted together stimulator sockets.

Check that the Patient Leakage current (From Patient stimulator sockets) does not exceed 100 μ A a.c. and 10 μ A d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.8.3 Patient Leakage Current Tests (From Patient amplifiers)-Single fault condition (Open Earth)

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open Earth)

The Patient Leakage current measurement for the Amplifiers must be made from the point formed where all of the amplifier input sockets are shorted together.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC.

When the Synergy application screen appears set it up as in section 8.4.

Check that the Patient Leakage current (From Patient amplifiers) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.8.4 Patient Leakage Current Tests (From Patient Stimulators)-Single fault condition (Open Earth)

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open Earth)

You will need to make a measurement connection from the Electrical Safety Testing Instrument to all the shorted together Stimulator sockets.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC.

When the Synergy application screen appears set it up as in section 8.4.

Check that the Patient Leakage current (From Patient Stimulator) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.8.5 Patient Leakage Current Tests (From Patient amplifiers) Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open supply)

The Patient Leakage current measurement for the Amplifiers must be made from the point formed where all of the amplifier input sockets are shorted together.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, Do not switch on the power switch on the PC.. As the unit is un-powered the setup in section 8.4 is not required.

Check that the Patient Leakage current (From Patient amplifiers) Single fault condition (Open supply) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.8.6 Patient Leakage Current Tests (From Patient Stimulators) Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure d.c. Patient Leakage Current in single fault condition (Open supply)

The Patient Leakage current measurement for the Stimulator must be made from the point formed where all of the Stimulators output sockets are shorted together.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, Do not switch on the power switch on the PC. As the unit un-powered the setup in section 8.4 is not required.

Check that the Patient Leakage current (From Patient Stimulators) Single fault condition (Open supply) does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.9 Patient Leakage Current Tests for External EMG Stimulator Probe

If the **External EMG Stimulator Probe** is supplied, then the some of the previous tests must be repeated.

You will need to make a measurement connection from the Electrical Safety Testing Instrument to both Stimulator Probe sockets shorted together.

For the Stimulator Probe to be used, you must Close down the Synergy Application and plug the Deluxe Stimulator Probe into the "🔌" connector in to the Patient Interface Unit. Then restart the Synergy Application and select **Stim B** from the stim setup. The Stimulator probe should then be functional.

DO NOT PRESS "STIM" DURING THESE TESTS, OTHERWISE YOU WILL GET A FALSE READING!

Repeat previous tests **8.16.2, 8.16.4 and 8.16.6 with External EMG Stimulator Probe.**

8.10 Patient Auxiliary Current (Patient Amplifier inputs and Internal Stimulator)

Note:-For the Internal Stimulator to be used, you must close down the Synergy Application and unplug the Deluxe Stimulator Probe (if present) from the "🔌" connector on the Patient Interface Unit. Then restart the Synergy Application and select **Stim A from the stim setup. The Internal Stimulator should then be functional. Do not press **STIM**.**

Note: Patient Auxiliary currents must be measured between any single patient connection and all other patient connections connected together. All the amplifier and internal stimulator connections must be included in these Auxiliary current tests.

8.10.1 Patient Auxiliary Current-Normal Condition

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Normal condition.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC.

When the Synergy application screen appears set it up as in section 8.4. Select **Stim A** from the stim setup.

Measured the Patient Auxiliary Current between **the first single patient connection** and **all other patient connections connected together.**

Check that the does not exceed 100µA a.c. and 10µA d.c.

Select **the second single patient connection**, **join the first single patient connection** to **all other patient connections connected together.**

Check that the current does not exceed 100µA a.c. and 10µA d.c.

Continue until every patient connection has been tested.

Check that the current does not exceed 100µA a.c. and 10µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

Switch off the unit.

8.10.2 Patient Auxiliary Current Leakage Current Single Fault Condition – Earth Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Earth Open.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC.

When the Synergy application screen appears set it up as in section 8.4. Select **Stim A** from the stim setup.

Repeat the sequence of testing in **8.18.1** measuring that the current between any single patient connection and **all** other patient connections connected together does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.10.3 Patient Auxiliary Current Leakage Current Single Fault Condition – Supply Open

Follow the instructions supplied with your Electrical Safety Testing Instrument to setup and measure Patient Auxiliary Current Leakage Current - Supply Open.

Connect the Synergy Plinth system as instructed to measure this current. Switch on the Isolation transformer (if used), the Plinth mains switch, Do not switch on the power switch on the PC. As the unit un-powered the setup in section 8.4 is not required.

Repeat the sequence of testing in 8.18.1 measuring that the current between any single patient connection and all other patient connections connected together does not exceed 500µA a.c. and 50µA d.c.

Repeat the above test with the mains Line and Neutral connections reversed.

8.11 Patient Auxiliary Current (Patient Amplifier inputs and External Stim Probe)

For the Stimulator Probe to be used, you must Close down the Synergy Application and plug the Deluxe Stimulator Probe into the "⚡" connector on the Patient Interface Unit. Then restart the Synergy Application and select **Stim B** from the stim setup. The Stimulator probe should then be functional.

Do not press STIM.

Note: Patient Auxiliary currents must be measured between any single patient connection and all other patient connections connected together. All the amplifier, internal stimulator and the Deluxe Stimulator Probe connections must be included in these Auxiliary current tests.

Repeat previous **tests 8.18.1, 8.18.2 and 8.18.3 with External EMG Stimulator Probe.**

Close down the application and switch off using the power switch on the Plinth PC. Disconnect the Electrical Safety Testing Instrument.

Remove all the connections used to test the patient applied parts.

Connect the unit directly to the mains supply, switch on and wait for Windows to "boot up".

8.12 Safety Checks EMG Stimulator

The tests in this section should be performed on both the Plinth Internal Stimulator and Deluxe Stimulator Probe (if fitted).

Begin testing with the Deluxe Stimulator Probe disconnected. Switch on the Isolation transformer (if used), the Plinth mains switch, the power switch on the PC.

When the Synergy application screen appears set it up as in section 8.4. Select **Stim A** from the stim setup.

8.12.1 Stimulus Fail Condition (Current Mode)

From the "Stimulus" drop down menu select "Electrical Stim Setup" (see figure 8.3). Set the **Output** to Current and the **Range** to High. Click on **OK** to return to the acquisition screen.

Connect the 3k3 load across the stimulus output connectors. Monitor across the load with the oscilloscope, connecting the probe earth lead to the black connector.

Using the control panel controls, set the **Duration** to 500µs and **Rep Rate** to 5pps. Set the stimulus level to 100mA.

Press **STIM** to turn on the stimulus, and check that a "Stim Fail Condition" error message is repeatedly displayed.

Set the stimulus level to 0mA, and check that the error message stops reappearing.

Press **STIM** to turn the stimulus off.

8.12.2 Over current Checks

Set the **Output** to Voltage and the **Range** to High.

Replace the 3k3 stimulus load with the 100Ω stimulus load and monitor across it with the oscilloscope as before. Increase the stimulus level to 300V. Press **STIM** again and check that the stimulus pulse displayed on the oscilloscope is now 10V±1V.

Press **STIM** to turn the stimulus off.

8.12.3 Stimulus Fail Condition (Voltage Mode)

Connect the 2k7 load across the stimulus output connectors and monitor across it with the oscilloscope. Set the stimulus level to 300V.

Press **STIM** to turn on the stimulus, and check that a "Stim Fail Condition" error message is repeatedly displayed.

Set the stimulus level to 0V, and check that the error message stops reappearing. Press **STIM** to turn the stimulus off.

8.12.4 Mark/Space Failure

Connect the 3k0 stimulus load across the stimulus output sockets and monitor across it with the oscilloscope. Set the stimulus level to 50V and press **STIM**. Set the **Repetition Rate** to 5pps and increase the **Duration** in stages.

Check that when the pulse duration is 500µs, the stimulus pulse amplitude displayed on the oscilloscope immediately falls to 0V, and a "Mark/Space Shutdown" error message is displayed. If testing a stimulator probe, check that both the polarity LEDs are now off, this shows that shutdown has occurred.

8.13 Safety Checks EMG External Stimulator Probe.

The tests in this section should be performed on the External Stim probe (if fitted).

Note:-For the probe to be detected, you must Close down the Synergy Application and plug the Stimulator Probe into the "🔌" connector on the Patient Interface Unit. Then restart the Synergy Application and select **StimB** from the stim setup. The probe should then be functional.

Repeat previous **tests 8.20.1, 8.20.2, 8.20.3 and 8.20.4 with External EMG Stimulator Probe.**

Close the Synergy Systems application and then shut down Windows. Switch Off the power switch on the PC, the Plinth mains switch and the the Isolation transformer (if used). Disconnect all test equipment.

This is the end of the Electrical Safety Tests for the Plinth System.

PIU SYSTEM FUNCTIONAL CHECKS

Note the **Plinth systems** require different tests please turn to the next chapter.

In order to perform the following tests, a basic knowledge of Windows is required to verify the system settings.

At the time of writing, the tests described in this chapter cover as many of the currently available options for the Synergy Systems as possible. Therefore some tests or signal connections may not be relevant to the system being tested.

9.1 Equipment Required

Oscilloscope (CRO) – 100MHz Dual Channel
 100Ω, 2k7, 3k0, 3k3 1%, EMG loads
 Decade Resistance Box
 Signal Generator
 Temperature probe
 Test printer
 Serial "loop back" connector (see section 6.13.2)
 3½" High density floppy disk (to check drive)
 CD-ROM (to check drive)
 Test SVGA colour monitor

9.2 System Connection

Almost all of these functional tests apply to all systems only the system connection will vary.

To view the correct **system connections** for your Tower, Notebook or Suite system see the relevant diagram in chapter 4.

In the case of **Notebook** systems you must connect the medical grade power supply, PC's power supply, notebook PC, PIU, mouse (Optional) and monitor (Optional) together but do not initially connect the optional EMG Stim probe.

In the case of **Tower** systems you must connect the Isolating Transformer, medical grade power supply, PC Tower, Keyboard, mouse, PIU and monitor together but do not initially connect the EMG Stim probe.

In the case of **Suite** systems you must connect the Isolating Transformer, medical grade power supply, PC Tower, Keyboard, mouse, monitor, PIU initially to the USB input of the tower PC, notebook PC's power supply and notebook PC; together but do not initially connect the EMG Stim probe. After completing testing the **Suite** system with the PIU initially connected to the USB input of the tower PC, then repeat testing with the PIU connected to the USB input of the Notebook PC.

After connecting the system as shown in the appropriate diagram, connect the Synergy systems mains inlet to the mains supply and switch on using the power switch on the PC.

Check that after the power on system test, the Windows logo is displayed in the centre of the screen. After a short period, the display should show the desktop. The Synergy application will be launched at startup, initially showing the Synergy logo and then showing the main application screen similar to that shown in Figure 9.1.

Verify that by moving the mouse around, the mouse pointer can be moved to all areas of the display.

9.3 System Checks

9.3.1 Time and Date Checks Checking via the Task Bar

Move the mouse pointer to the four edges of the display in turn and at one edge, the Windows "Taskbar" will appear with any minimized applications displayed on it. (The factory default position for the taskbar is the bottom of the display). If the taskbar does not appear, probably due to the way the user has configured the system, press the **Ctrl** and **Esc** keys together, and the "Start" menu and taskbar will appear. The current time may be displayed on the taskbar – this again depends on how the user has configured the system. If the time is not shown, go to the next section. If the time is shown, check that it is correct. Move the mouse pointer over the displayed time – a box will appear above it showing the date. Check that the date displayed is correct.

If either the time or the date are incorrect, "double clicking" the left mouse button with the pointer over the displayed time will bring up the **Day/Time Properties** box. The date and time can then be corrected.

Select **Time Zone** and verify that the correct zone is selected. If necessary, adjust the time zone for the local area.

When the settings are correct, click on **OK**.

Checking via the Windows Control Panel

If the time is not displayed on the Task Bar, click on the Start menu, select **Settings** and then **Control Panel**. Double-click on **Date/Time** to bring up the **Day/Time Properties** box. The date and time can then be corrected.

Select **Time Zone** and verify that the correct zone is selected. If necessary, adjust the time zone for the local area.

When the settings are correct, click on **OK** and then close the Control Panel box.

9.3.2 Keyboard Language Setting

Open the Control Panel and click on **Keyboard** to display the Keyboard Properties box. Select **Language** and **General** in turn, and check that the settings for the keyboard are correct. If necessary, change the settings as required and click on **OK**.

To change the keyboard language, click on **Add** and then select the language required. Click on the original language and select **Remove** and then click on **OK**. A warning will be displayed that the original keyboard language will not be removed until Windows is restarted. The keyboard language will also be displayed at the bottom right of the taskbar, while both keyboard languages are available.

9.3.3 Regional Settings Check

From the Control Panel select **Regional Settings**. Select each "tab" for the regional settings in turn and check that the settings/format for **Regional Settings**, **Number**, **Currency**, **Time**, and **Date** are correct, changing any if necessary. Click on **OK** to save the settings.

Close down the Control Panel and then maximise the EMG application that was minimized earlier.

9.4 CD-ROM Drive Checks

Open the CD-ROM drive, by pressing the button on the drive tray. Fit a CD-ROM into the drive spindle with the label side uppermost, and then close the tray by pushing the button again.

Start **Windows Explorer** and click on the CD-ROM drive icon. Check that the CD-ROM drive activity light flashes as the CD directory is read.

Check that a list of directories and/or files is displayed in the right hand pane. Check that no undue noises are made by the drive as the CD disk spins and is accessed

Select various directories in the left hand pane. Check that the contents of the selected directory appears in the right hand pane. When CD-ROM drive activity has stopped, close **Windows Explorer** and remove the CD disk.

9.5 Patient Amplifier Checks

Set the Signal Generator to give a 10mV pk-pk 1kHz sinewave output. Connect the Signal Generator to the red sockets on the Patient Amplifier inputs, on the Patient Interface Unit. Also connect the signal return to the black and green sockets joined together.

Double click on **Sensory NCS** folder in the **Test Menu** in the right hand window, click **OK** in the **Select Protocol** dialog box.

The display will now change to show the monitor trace/s on the lower right and store / cascade traces on the left.

Select the **Acquisition** drop-down menu and then select **Setup**. Use the mouse to select each channels parameters page tab and if necessary turn the channel **On**. Set **Amp Gain** to **10mV**, **Filters / Low** to **1Hz**, **Filters / High** to **10kHz**, **Sensitivities / Monitor, Stores, Cascades** to **5mV** for both channels. Click on **OK** when finished.

Set the **AMP On/Off** switch on the Patient Interface Unit to **On**. Press the momentary **Acquire** button to load store traces.

Check that both store traces display a 2 division sinewave

Select the **Acquisition** drop-down menu and then select **Setup**. Use the mouse to select each channels parameters page tab. Set **Amp Gain** to **500mV**, **Sensitivities / Monitor, Stores, Cascades** to **5mV** for both channels. Click on **OK** when finished.

Press the momentary **Acquire** button to load store traces.

Check that both store traces display a 2 division sinewave.

9.6 Trigger / Gain / Sweep Control Checks

From the **Test Menu** select **Needle EMG**. Select **Cancel** on the **EMG Summary Menu**. Press in the **TRIGGER** switch on the Patient Interface Unit to turn triggering **On**.

Check that a trigger level marker appears and that the monitor trace no longer free runs.

Rotate the **Trigger** control on the Patient Interface Unit over its full travel. Check that the sinewave can be triggered over its full amplitude

Check that when the trigger level is above or below the sinewave, the trace free runs.

Press the +/- button on the Patient Interface Unit to select the positive trigger edge. Check that the sinewave can be triggered over the full amplitude of the positive going edge.

Press the **Trigger** control on the Patient Interface Unit to turn triggering **Off**. Check that the trigger level marker disappears.

Press in the **Trigger** switch on the Patient Interface Unit to turn triggering **On**. Check that a trigger level marker reappears. Check that the monitor trace no longer free runs

Rotate the **Trigger** control on the Patient Interface Unit over its full travel. Check that the sinewave can be triggered over its full amplitude.

Check that when the trigger level is above or below the sinewave, the trace free runs.

Press the +/- **button** on the Patient Interface Unit to select the negative trigger edge. Check that the sinewave can be triggered over the full amplitude of the negative edge.

Rotate the **Gain** and **Sweep** controls on the Patient Interface Unit. Check that the gain of the displayed sinewave can be adjusted.

Check that the sweep duration can be adjusted i.e. the number of cycles of the sinewave increases and decreases as the sweep duration increases and decreases.

Rotate the **Gain** and **Sweep** controls on the Patient Interface Unit and check that the gain of the displayed sinewave can be adjusted

Check that the sweep duration can be adjusted i.e. the number of cycles of the sinewave increases and decreases as the sweep duration increases and decreases.

Press the 'momentary' **Acquire** button on the Patient Interface Unit.

Check that the green LED next to the **Acquire** button, briefly flashes and that the active store trace is updated once.

Press the **Next** button on the Patient Interface Unit and check that the next store trace has been made the active store.

Press the 'latching' **Acquire** button on the Patient Interface Unit. Check that the green LED next to the **Acquire** button, remains on, and that the new active store trace is repeatedly updated.

Press either **Acquire** button again. Check that the green LED next to the **Acquire** button, turns off, and that the active store trace stops updating.

9.6.1 Amp Cal Mode

Disconnect the Signal Generator from the Patient Interface Unit. Set the **AMP ON/OFF** switch on the Patient Interface Unit to **Off**. From the **Test Menu** select **Sensory NCS**. From the main menu select **System / Calibration On**. The calibration signal is a 1mV Squarewave.

Select the **Acquisition** drop-down menu and then select **Setup**. Set **Amp Gain** to **500mV**. Select each channels parameters page tab. Set **Filters / Low** to **1Hz**, **Filters / High** to **10kHz**, **Sensitivities / Monitor**, **Stores**, **Cascades** to **2mV** for both channels. Click on **OK** when finished.

Check that a free running Amp-cal waveform of 2.5 div pk-pk, is displayed on all monitor traces.

From the main menu select **System / Calibration Off** to turn the calibration signal off.

Return the **AMP ON/OFF** switch on the Patient Interface Unit to **ON**.

9.6.2 Temperature Probe Checks

Plug the temperature probe into the socket on the Patient Interface Unit. From the **Test Menu**, select the **Default 2** menu and then **Motor NCS**.

Check that the temperature shown in the box at the top of the display is showing the ambient temperature. Hold the probe in your hand and check that the displayed temperature increases accordingly. (Body temperature is 37°C).

9.6.3 Patient Interface Unit Internal EMG Stimulator Checks

Note:-For the Internal Stimulator to be used, you must Close down the Synergy Application and un-plug the Deluxe Stimulator Probe (if present) from the "🔌" connector in to the Patient Interface Unit. Then restart the Synergy Application and select **Stim A** from the stim setup. The Internal Stimulator should then be functional.

Connect the 3k0 load across the stimulus output connectors '⌚' on the side of the Patient Interface Unit. Monitor across the load with the CRO.

Select the **Stimulus** drop-down menu and then select **Electrical Stim Setup**. Set the **Output** to **Voltage**, **Rep. Rate** to **5pps**, **Duration** to **0.5ms**, **Range** to **High** and **Polarity** to **+**, **Limit** to **300V**. Click on **OK**. Press **STIM** on the Patient Interface Unit. Gradually increase the stimulus level control on the Patient Interface Unit to 300V, as displayed below the main menu bar.

Check that the amber LED next to the **STIM** button illuminates, and check on the CRO for a 300V stimulus pulse of 500µs duration every 200ms.

Rotate the stimulus level control over its full travel, and check that the amplitude of the stimulus pulse can be varied continuously and smoothly between 0V and 300V.

Return the stimulus level to 0V and press **Stim** on the to turn off the stimulator output. Check that the amber LED on the Patient Interface Unit turns off.

Replace the 3k0 load with the 2k7 load and monitor across it with the CRO.

Press **STIM** and gradually increase the stimulus level to maximum (300V).

Check that when the stimulus intensity setting is approximately 270V, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red.

Return the stimulus level to minimum and press **Stim** on the Patient Interface Unit to turn the stimulator output off.

Replace the 2k7 load with the 3k0 stim load and monitor across it with the CRO.

Set the stimulus **Output** to **Current**, then click on **OK**. Press **STIM** and gradually increase the stimulus level to maximum (100mA).

Check on the CRO for a 300V stimulus pulse (100mA x 3k0) of 500µs duration every 200ms

Rotate the stimulus level control over its full travel.

Check that the amplitude of the stimulus pulse can be varied continuously and smoothly between 0 and 300V, (0 - 100mA).

Return the stimulus level to minimum and press **STIM** on the Patient Interface Unit to turn off the stimulator output.

Replace the 3k0 stim load with the 3k3 stim load and monitor across it with the CRO.

Press **STIM** and gradually increase the stimulus level to maximum.

Check that when the stim intensity setting is approximately 90mA, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red..

Return the stimulus level to minimum and press **STIM** on the Patient Interface Unit to turn off the stimulator output.

Replace the 3k3 stim load with the 3k0 load. Press **STIM** and set the stim intensity to **50mA**. Rotate the **Stim Duration** control on the Patient Interface Unit.

Check that stim durations of 0.05ms, 0.1ms, 0.2ms, 0.5ms & 1ms can be selected.

EMG Stimulator Probe Checks

The following checks apply to the Deluxe Stimulator Probe if fitted.

Connect the 3k0 load across the stimulus output connectors on the probe. Monitor across the load with the CRO. (Connect CRO signal to probe output above the $\perp$ connector. Connect CRO 0v to probe output above the +/- connector).

Note:-For the probe to be detected, you must close down the Synergy Application and plug the Stimulator Probe into the "" connector in to the Patient Interface Unit. Then restart the Synergy Application and select **StimB** from the stim setup. The probe should then be functional.

Setup **STIM B** as follows in Electrical Stim Setup. Set the **Output** to **Voltage**, **Rep. Rate** to **5pps**, **Duration** to **0.5ms**, **Range** to **High** and **Polarity** to **+**, **Limit** to **300V**. Click on **OK**. Press $\perp$ on the probe then gradually increase the stimulus level control on the Stimulus Probe to 300V, as displayed below the main menu bar.

Check that the "LED marked +" above the $\perp$ button on the Stim probe is illuminated (if not press the +/- button). Check that the LED above the Stim button on the PIU is now illuminated.

Check on the CRO for a 300V stimulus pulse of 500µs duration every 200ms.

Rotate the stimulus level control over its full travel checking that the amplitude of the positive going stimulus pulse can be varied continuously and smoothly between 0 and 300V.

Press the +/- button on the Stim probe checking that the negative going stimulus pulse can be varied continuously and smoothly between 0 and -300V. Check that the "LED marked +" above the +/- button on the Stim probe is illuminated.

Press the +/- button on the Stim probe check that the stimulus pulse is again positive going. Check that the "LED marked +" next to the $\perp$ button on the Stim probe is illuminated.

Press the $\perp$ on the probe check that the Stim is turned off. Check that the LED above the Stim button on the PIU is not illuminated.

Briefly press in the **Rotary stimulus level control** on the probe and check that both the stim and green acquire LED,s briefly light on the PIU. A stim is generated and trace is acquired.

Press and hold in (for < 1s) the **Rotary stimulus level control** on the probe and check that both the stim and green acquire LED,s light and on the PIU. Check acquire and stim are now latched on, the trace on the left hand screen is constantly updated.

Briefly press in the **Rotary stimulus level control**, Check acquire and stim are now latched off.

Return the stimulus level to minimum.

Replace the 3k0 load with the 2k7 load and monitor across it with the CRO.

Press $\downarrow$ and gradually increase the stimulus level to maximum.

Check that when the stimulus intensity setting is approximately 270V, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red..

Return the stimulus level to minimum and press $\downarrow$ to turn the stimulator output off.

Replace the 2k7 load with the 3k0 load and monitor across it with the CRO.

Set the stimulus **Output** to **Current**, then click on **OK**. Press $\downarrow$ and gradually increase the stimulus level to maximum, 100mA.

Check on the CRO for a 300V stim pulse (100mA x 3k0) of 500 μ s duration every 200ms.

Rotate the stimulus level control over its full travel, and check that the amplitude of the stimulus pulse can be varied continuously and smoothly between 0 and 300V, (0 - 100mA).

Return the stimulus level to minimum and press $\downarrow$ to turn off the stimulator output.

Replace the 3k0 load with the 3k3 load and monitor across it with the CRO.

Press $\downarrow$ and gradually increase the stimulus level to maximum.

Check that when the stim intensity setting is approximately 90mA, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red.

Return the stimulus level to minimum and press $\downarrow$ to turn the stimulator output off.

9.6.4 Speaker Checks

For built in speakers in the monitors for **Tower**, **Suite** and for internal speakers in the **Notebook** system.

Caution : Mains powered external speakers must not be used with the Synergy Notebook.

Un-powered headphones or battery powered external speakers can be used but remember to switch them off after use.

Set the Signal Generator to give a 10mV pk-pk 1KHz sinewave output. On a Patient Interface Unit, connect the signal output to the red sockets on the Patient Interface Unit and the signal ground to the green and black sockets joined together.

Adjust the amplifier gain to give a 2 div sinewave on the monitor traces.

Select the **Acquisition** drop-down menu and then select **Setup**. Select **Audio Setup** and then click in the **Audio On/Off** box to turn audio on. The internal speaker will now be active, gradually increase the Patient Interface Unit **Volume** control.

Note:-There may also be a volume control on the Notebook PC or in the case of the Tower system on the monitor for the built in speakers this should be gradually increased. The Windows volume control on the task bar must not be muted and should be set to near maximum. To check the windows volume setting use the mouse and click the speaker symbol at the right hand end of the task bar.

Check that the 1kHz tone can be heard from the internal loud speakers.

Check that the tone is clear and undistorted.

Vary the Signal Generator frequency from 100Hz to 10kHz and vary the volume. Check that the tone is clear and undistorted.

Now plug the (non mains powered) external speakers or headphones into the Audio output socket on the notebook PC and repeat checks as above.

Return the **Volume** control to minimum.

Disconnect the Signal Generator from the Patient Interface Unit.

9.6.5 Footswitch Checks

Plug the single footswitch assembly into the ' $\geq$ ' connector on the Patient Interface Unit.

Briefly operate the **Acquire** footswitch. Check that the green LED next to the **Acquire** button on the Patient Interface Unit, flashes briefly.

Check that the active store trace is updated once.

Press the **NEXT** button on the Patient Interface Unit.

Check that the next store trace has been made the active store.

Operate the **Acquire** footswitch again, holding it depressed for >1s. Check that the green LED next to the **Acquire** button on the Patient Interface Unit, remains illuminated. Check that the new active store trace is repeatedly updated

Briefly operate the **Acquire** footswitch again, and check that the green LED next to the **Acquire** button, turns off. Check that the active store trace stops updating.

9.6.6 Temperature Probe Input check

While in the **Sensory NCS** test which includes temperature measurement in the setup connect the probe and check that the room temperature is measured and displayed. Check the reading can be varied if you hold or breathe on the probe.

The Temperature Probe Input on the end panel of the PIU, is designed for use with YSI series 400 or 4400 probes with resistance of 2253Ω at 25°C. Reusable and Disposable types available (see chapter 10)

Note: Disposable types cannot be connected directly, an extension/adaptor cable is required.

When the correct type of probe is connected to the input a range 15°C to 40°C with 0.1°C resolution, 0.2°C accuracy can be measured. If the temperature is outside this range then the display will read -----°C.

9.7 Parallel & Serial Port Checks

 **Peripheral equipment not supplied by Oxford Instruments should not be connected.**

9.7.1 Parallel Port

To perform these checks, the Windows printer driver for the printer being used must have been previously installed.

Connect the printer to the parallel port connector marked " " on the rear of the PC. Ensure it is loaded with paper and switch it on. From the **Task Bar** click on **Start**, select **Programs**, then select **Accessories**, then click on **WordPad**.

When **WordPad** has loaded, click on **File**, then **Open**. Select and load a document or text file ***.doc** or ***.txt**. When the file has loaded, click on the **Printer** icon and the document will be printed.

Check that the printer prints the document and that what is printed is correct.

Exit the WordPad application.

9.7.2 Serial COM Port

Make a "loop back" connector by shorting together pins 2 and 3 of a 9-way D type socket. Insert this connector, into the **COM** port on the rear of the PC.

Start the **Hyper Terminal** application, (**Start / Programs / Accessories / Hyper Terminal**). Double click on the **Hypertrm.exe** icon.

When asked to enter a **Name** for the **Connection Description**, type **Test** then click on **OK**.

In the **Phone Number** window, set **Connect using** to **Direct to Com**, click on **Ok**.

In the **COM Properties** window set :-

Bits per second 9600
Data bits 8
ParityNone
Stop bits 1
Flow controlNone

Click on **OK**.

Type any characters on the keyboard, and check that the characters typed appear in the Hyper Terminal window.

Remove the 'loopback' connector, and type on the keyboard.

Check that the characters typed no longer appear in the Hyper Terminal window.

Exit **Hyper Terminal**. When asked if you want to disconnect, click on **OK**. When asked if you want to save the session, click on **NO**.

9.7.3 Networking Checks (Suite System Only)

The checks described in this section first check that the Tower PC can see the Notebook PC and vice versa.

A PCMCIA network module (PCMCIA) approved by the Notebook PCs manufacturer should be fitted into a PC Card Slot in the Notebook. This will normally be connected via a short lead to a pod (Media coupler for network). The pod will contain the larger connector required for the network connection.

Normally this will be a Network direct connection –with a CAT5 shielded (STP) Patch Cable - Crossover (RJ45 connectors)

When the two PC's are connected together, ensure that at least one directory is shared. To share a directory proceed as follows.

Start **Windows Explorer**, right click on a directory and then select **Sharing ...**. Click on **Shared As :**, then click on **Apply**, then **Ok**.

Start **Windows Explorer** on both systems and click on the + box next to the **Entire Network** icon. There will be a delay while the network is searched for connected systems.

Check that a list of connected systems appears in the right hand window.

Select a system sharing directories on the network, then select a directory on that system.

Check that the directory contents are displayed in the right hand pane.

Close down the Synergy Systems application and then Windows. Switch off the unit and disconnect all test equipment.

9.7.4 If a connection is required via a local network

You are first advised to have completed the checks described in the previous section. This will check that the Tower PC can see the Notebook PC and vice versa when directly connected.

Normally this will be a Network connection via a **hub using RJ45** connectors.

Note The STP cables must be the normal type without crossover.

For advice on **other methods** of network connection between the Synergy Systems contact your network administrator or contact Oxford Instruments Support.

When the two PC's are connected together, via the network ensure that at least one directory is shared. To share a directory proceed as follows.

Start **Windows Explorer**, right click on a directory and then select **Sharing ...**. Click on **Shared As :**, then click on **Apply**, then **Ok**.

Start **Windows Explorer** on both systems and click on the + box next to the **Entire Network** icon. There will be a delay while the network is searched for connected systems.

Check that a list of connected systems appears in the right hand window.

Select a system sharing directories on the network, then select a directory on that system.

Check that the directory contents are displayed in the right hand pane.

Close down the Synergy Systems application and then Windows. Switch off the unit and disconnect all test equipment.

Close down the Synergy Systems application and then Windows. Switch off the system and disconnect all test equipment.

PLINTH SYSTEM FUNCTIONAL CHECKS

Note the **PIU systems** require different tests please turn to the previous chapter.

In order to perform the following tests, a basic knowledge of Windows is required to verify the system settings.

At the time of writing, the tests described in this chapter cover as many of the currently available options for the Synergy Systems as possible. Therefore some tests or signal connections may not be relevant to the system being tested.

10.1 Equipment Required

Oscilloscope (CRO) – 100MHz Dual Channel
100Ω, 2k7, 3k0, 3k3 1%, EMG loads
Decade Resistance Box
Signal Generator Thandar TG501 or similar
Temperature probe
Test printer
Serial "loop back" connector (see section 6.13.2)
3½" High density floppy disk (to check drive)
CD-ROM (to check drive)
Test SVGA colour monitor

Leads required:-

Plus a lead to connect your Function Generator to the amplifier inputs (probably BNC to touchproofs)

Plus Touchproof jumper links as required. (5 for a 5 channel Amplifier) and (10 for a 10 channel Amplifier)

10.2 System Connection

Almost all of these functional tests apply to all systems only the system connection and number of channels will vary.

To view the correct **system connections** for your **Tower Plinth** or **Notebook Plinth system** see the relevant diagram in chapter 3.

In the case of **Notebook** systems you must connect the Plinth, DC to DC Adaptor, notebook PC, control panel, (Optional) Isolation transformer and but initially do not initially connect the (optional) EMG Stim probe.

In the case of **Tower** systems you must connect the Isolating Transformer, the Plinth, control panel, PC Tower, Keyboard, mouse and monitor together but do not initially connect the EMG Stim probe.

After connecting the system as shown in the appropriate diagram, connect the Synergy systems mains inlet to the mains supply. Switch on the Isolation transformer (if used), the Plinth mains switch and the power switch on the PC.

Check that after the power on system test, the Windows logo is displayed in the centre of the screen. After a short period, the display should show the desktop. The Synergy application will be launched at startup, initially showing the Synergy logo and then showing the main application screen similar to that shown in Figure 10.1.

With the **Tower** and **Notebook Plinth systems** verify that the pointing device on the control panel moves the on screen pointer to all areas of the display.

With the **Notebook Plinth system** verify that the pointing device in the **Notebook PC** also moves the on screen pointer to all areas of the display.

Optionally the **Tower or Notebook Plinth** systems can be controlled with a standard mouse plugged into the PC PS2 port. This can be used in place of the Control Panel Pointing Device but it is not possible to use both at once as there is only one connector.

Check when the on screen pointer is at one edge of the display the task bar will appear. The default edge is the bottom, but this can be changed by the user.

10.3 System Checks

10.3.1 Time and Date Checks Checking via the Task Bar

Move the on screen pointer to the four edges of the display in turn and at one edge, the Windows "Taskbar" will appear with any minimized applications displayed on it. (The factory default position for the taskbar is the bottom of the display). If the taskbar does not appear, probably due to the way the user has configured the system, press the **Ctrl** and **Esc** keys together, and the "Start" menu and taskbar will appear. The current time may be displayed on the taskbar – this again depends on how the user has configured the system. If the time is not shown, go to the next section. If the time is shown, check that it is correct. Move the on screen pointer over the displayed time – a box will appear above it showing the date. Check that the date displayed is correct.

If either the time or the date are incorrect, "double clicking" the left pointing device button with the pointer over the displayed time will bring up the **Day/Time Properties** box. The date and time can then be corrected.

Select **Time Zone** and verify that the correct zone is selected. If necessary, adjust the time zone for the local area.

When the settings are correct, click on **OK**.

Checking via the Windows Control Panel

If the time is not displayed on the Task Bar, click on the Start menu, select **Settings** and then **Control Panel**. Double-click on **Date/Time** to bring up the **Day/Time Properties** box. The date and time can then be corrected.

Select **Time Zone** and verify that the correct zone is selected. If necessary, adjust the time zone for the local area.

When the settings are correct, click on **OK** and then close the Control Panel box.

10.3.2 Keyboard Language Setting

Open the Control Panel and click on **Keyboard** to display the Keyboard Properties box. Select **Language** and **General** in turn, and check that the settings for the keyboard are correct. If necessary, change the settings as required and click on **OK**.

To change the keyboard language, click on **Add** and then select the language required. Click on the original language and select **Remove** and then click on **OK**. A warning will be displayed that the original keyboard language will not be removed until Windows is restarted. The keyboard language will also be displayed at the bottom right of the taskbar, while both keyboard languages are available.

10.3.3 Regional Settings Check

From the Control Panel select **Regional Settings**. Select each "tab" for the regional settings in turn and check that the settings/format for **Regional Settings**, **Number**, **Currency**, **Time**, and **Date** are correct, changing any if necessary. Click on **OK** to save the settings.

Close down the Control Panel and then maximise the EMG application that was minimized earlier.

10.4 CD-ROM Drive Checks

Open the CD-ROM drive, by pressing the button on the drive tray. Fit a CD-ROM into the drive spindle with the label side uppermost, and then close the tray by pushing the button again.

Start **Windows Explorer** and click on the CD-ROM drive icon. Check that the CD-ROM drive activity light flashes as the CD directory is read.

Check that a list of directories and/or files is displayed in the right hand pane. Check that no undue noises are made by the drive as the CD disk spins and is accessed

Select various directories in the left hand pane. Check that the contents of the selected directory appears in the right hand pane. When CD-ROM drive activity has stopped, close **Windows Explorer** and remove the CD disk.

10.5 Patient Amplifier Checks

The amplifier setups and number of traces to be checked will vary for 2, 5 or 10 channel amplifiers but **all** Inputs must be tested.

For 2 channel amplifiers

Set the Signal Generator to give a 10mV pk-pk 1kHz sinewave output. Connect the Signal Generator to the both red sockets on the Patient Amplifier inputs, on the Amplifier. Also connect the signal return to the both black and green sockets joined together.

For 5 or 10 channel amplifiers

Join the EMG 1 black connector to one of the green Neutral connectors.
Set the Function Generator output to give a 10mV pk-pk 1kHz sinewave. Connect the Function Generator to the amplifier inputs, signal to the EMG 1 red connector and the return to the joined EMG 1 black & green Neutral connectors..
Continue connecting to others as in the following table.

	Generator 0V connected TO	Generator Signal Output connected TO
FOR 5 CHAN AMP	EMG 1 Black	
	LINK to Green Neutral connector	EMG 1 Red
		EMG 2 Red
		X2
		X4
PLUS IF 10 CHAN AMP		X6
		X1
		X3
		X5
		A1
		A2

Double click on **Sensory NCS** folder in the **Test Menu** in the right hand window, click **OK** in the **Select Protocol** dialog box.

The display will now change to show the monitor trace/s on the lower right and store / cascade traces on the left.

Select **Acquisition / Setup** . Select each channel's parameters page tab and if necessary turn the channel **On** (by ticking the box). Set **Amp Range** to **10mV**, **Filters / Low** to **1Hz**, **Filters / High** to **10kHz**, **Sensitivities / Monitor, Stores, Cascades** to **10mV** for all channels.

Note the **"Apply to All"** can be used to set the parameters of all channels the same. This does not set active electrodes to channels.

In all channels 1 to 5 or 6 to 10 set **Active** electrode to **The same as where the inputs are connected** i.e.

Channel 1 to EMG1 +,
Channel 2 to EMG2 +,
Channel 3 to X2
Channel 4 to X4
Channel 5 to X6

Channel 6 to X1
Channel 7 to X3
Channel 8 to X5
Channel 9 to A1
Channel 10 to A2

and Reference electrode for all channels to Neutral.

Click on **OK** when finished.

If necessary press the **AMP On/Off** button on the Headbox, to turn the Headbox **On** the green Amp On LED should be illuminated.

Press the **Acquire** button check Acquire LED lights and the stores are updating traces each time a set of stims has been delivered to an output. Set the **Sweep duration** to **10ms**.

Check that all monitor traces display a 1 div sinewave. Also the stores have all been filled with 1KHz sinewaves.

Select **Acquisition / Setup**. Use the mouse to select each channel's parameters page tab. Set **Amp Range** to **500mV**, **Sensitivities / Monitor, Stores, Cascades** to **5mV** for all channels. Click on **Ok** when finished.

Press the **Acquire** button to load store traces.

Check that all store traces display a 1 div. sinewave.

10.6 Trigger / Gain / Sweep Control Checks

From the **Test Menu** select **Needle EMG**. Select **Cancel** on the **EMG Summary Menu**. Press in the **TRIGGER** switch on the control panel to turn triggering **ON**.

Check that a trigger level marker appears and that the monitor trace no longer free runs.

Rotate the **Trigger** control on the control panel over its full travel. Check that the sinewave can be triggered over its full amplitude

Check that when the trigger level is above or below the sinewave, the trace free runs.

Press the +/- button on the control panel to select the positive trigger edge. Check that the sinewave can be triggered over the full amplitude of the positive going edge.

Press the **Trigger** control on the control panel to turn triggering **Off**. Check that the trigger level marker disappears.

Press in the **Trigger** switch on the control panel to turn triggering **On**. Check that a trigger level marker reappears. Check that the monitor trace no longer free runs

Rotate the **Trigger** control on the control panel over its full travel. Check that the sinewave can be triggered over its full amplitude.

Check that when the trigger level is above or below the sinewave, the trace free runs.

Press the +/- **button** on the control panel to select the negative trigger edge. Check that the sinewave can be triggered over the full amplitude of the negative edge.

Rotate the **Gain** and **Sweep** controls on the control panel. Check that the gain of the displayed sinewave can be adjusted.

Check that the sweep duration can be adjusted i.e. the number of cycles of the sinewave increases and decreases as the sweep duration increases and decreases.

Rotate the **Gain** and **Sweep** controls on the control panel and check that the gain of the displayed sinewave can be adjusted

Check that the sweep duration can be adjusted i.e. the number of cycles of the sinewave increases and decreases as the sweep duration increases and decreases.

Press the 'momentary' **Acquire** button on the control panel.

Check that the green LED next to the **Acquire** button, briefly flashes and that the active store trace is updated once.

Press the **Next** button on the control panel and check that the next store trace has been made the active store.

Press the 'latching' **Acquire** button on the control panel. Check that the green LED next to the **Acquire** button, remains on, and that the new active store trace is repeatedly updated.

Press either **Acquire** button again. Check that the green LED next to the **Acquire** button, turns off, and that the active store trace stops updating.

10.6.1 Amp Cal Mode for 2 channel amplifiers

Disconnect the Signal Generator from the amplifier. Set the **AMP ON/OFF** switch on the amplifier to **Off**. From the **Test Menu** select **Sensory NCS**. From the main menu select **System / Calibration On**. The calibration signal is a 1mV Squarewave.

Select the **Acquisition** drop-down menu and then select **Setup**. Set **Amp Gain** to **500mV**. Select each channels parameters page tab. Set **Filters / Low** to **1Hz**, **Filters / High** to **10kHz**, **Sensitivities / Monitor**, **Stores, Cascades** to **2mV** for both channels. Click on **OK** when finished.

Check that a free running Amp-cal waveform of 2.5 div pk-pk, is displayed on all monitor traces.

From the main menu select **System / Calibration Off** to turn the calibration signal off.

Return the **AMP ON/OFF** switch on the control panel to **ON**.

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10.6.2 Calibration and filter check for 5 or 10 channel amplifiers

Disconnect the Signal Generator from the Headbox. Set the **AMP ON/OFF** switch on the Headbox to **Off**. From the **Test Menu** select **Sensory NCS**. From the main menu select **System / Calibration On**.

Select **Display, Trace area setup**, in Global trace area parameters, set default trace type to **monitor**, set attributes to **Full**.

This should show the monitor traces on the whole screen

For Amplifiers change the **Acquisition Setup ...** For all channels as follows :-

Amp Range to 500mV
Filters / Low to 0.01Hz
Filters / High to 10Hz
Sentivities / Monitor to 500µV
Sweep 100ms
Amplifier Inputs
Active to EMG1+
Reference to Neutral

Click on **Ok** when finished.

Check that a free running Amp-cal waveform of 1 div pk-pk, is displayed on all monitor traces..

Vary the filter **frequency settings** for all channels and check that the shape of the Calibration trace is altered but remains similar on all channels.

From the main menu select **System / Calibration Off** to turn the calibration signal off.

10.6.3 Temperature Probe Checks

Plug the temperature probe into the socket on the Amplifier. From the **Test Menu**, select the **Default 2** menu and then **Motor NCS**.

Check that the temperature shown in the box at the top of the display is showing the ambient temperature. Hold the probe in your hand and check that the displayed temperature increases accordingly. (Body temperature is 37°C).

Check the other connection points for the Probe.

10.6.4 Control panel Control Panel EMG Stimulator Checks

Note:-For the Control Panel Stimulator to be used, you must Close down the Synergy Application and un-plug the Deluxe Stimulator Probe (if present) from the "🔌" connector in to the .Plinth Then restart the Synergy Application and select **Stim A** from the stim setup. The Control Panel Stimulator should then be functional.

Connect the 3k0 load across the stimulus output connectors 'JL⊕-' on the side of the control panel. Monitor across the load with the CRO.

Select the **Stimulus** drop-down menu and then select **Electrical Stim Setup**. Set the **Output to Voltage, Rep. Rate to 5pps, Duration to 0.5ms, Range to High and Polarity to +, Limit to 300V**. Click on **OK**. Press **STIM** on the control panel. Gradually increase the stimulus level control on the control panel to 300V, as displayed below the main menu bar.

Check that the amber LED next to the **STIM** button illuminates, and check on the CRO for a 300V stimulus pulse of 500 μ s duration every 200ms.

Rotate the stimulus level control over its full travel, and check that the amplitude of the stimulus pulse can be varied continuously and smoothly between 0V and 300V.

Return the stimulus level to 0V and press **Stim** on the to turn off the stimulator output. Check that the amber LED on the control panel turns off.

Replace the 3k0 load with the 2k7 load and monitor across it with the CRO.

Press **STIM** and gradually increase the stimulus level to maximum (300V).

Check that when the stimulus intensity setting is approximately 270V, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red.

Return the stimulus level to minimum and press **Stim** on the control panel to turn the stimulator output off.

Replace the 2k7 load with the 3k0 stim load and monitor across it with the CRO.

Set the stimulus **Output to Current**, then click on **OK**. Press **STIM** and gradually increase the stimulus level to maximum (100mA).

Check on the CRO for a 300V stimulus pulse (100mA x 3k0) of 500 μ s duration every 200ms

Rotate the stimulus level control over its full travel.

Check that the amplitude of the stimulus pulse can be varied continuously and smoothly between 0 and 300V, (0 - 100mA).

Return the stimulus level to minimum and press **STIM** on the control panel to turn off the stimulator output.

Replace the 3k0 stim load with the 3k3 stim load and monitor across it with the CRO.

Press **STIM** and gradually increase the stimulus level to maximum.

Check that when the stim intensity setting is approximately 90mA, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red..

Return the stimulus level to minimum and press **STIM** on the control panel to turn off the stimulator output.

Replace the 3k3 stim load with the 3k0 load. Press **STIM** and set the stim intensity to **50mA**. Rotate the **Stim Duration** control on the control panel.

Check that stim durations of 0.05ms, 0.1ms, 0.2ms, 0.5ms & 1ms can be selected.

10.6.5 EMG Stimulator Probe Checks

The following checks apply to the Deluxe Stimulator Probe if fitted.

Connect the 3k0 load across the stimulus output connectors on the probe. Monitor across the load with the CRO. (Connect CRO signal to probe output above the $\perp$ connector. Connect CRO 0v to probe output above the +/- connector).

Note:-For the probe to be detected, you must close down the Synergy Application and plug the Stimulator Probe into the "🔌" connector in to the Plinth. Then restart the Synergy Application and select **StimB** from the stim setup. The probe should then be functional.

Setup **STIM B** as follows in Electrical Stim Setup. Set the **Output to Voltage, Rep. Rate to 5pps, Duration to 0.5ms, Range to High and Polarity to +, Limit to 300V**. Click on **OK**. Press $\perp$ on the probe then gradually increase the stimulus level control on the Stimulus Probe to 300V, as displayed below the main menu bar.

Check that the "LED marked +" above the $\perp$ button on the Stim probe is illuminated (if not press the +/- button). Check that the LED above the Stim button on the control panel is now illuminated.

Check on the CRO for a 300V stimulus pulse of 500 μ s duration every 200ms.

Rotate the stimulus level control over its full travel checking that the amplitude of the positive going stimulus pulse can be varied continuously and smoothly between 0 and 300V.

Press the +/- button on the Stim probe checking that the negative going stimulus pulse can be varied continuously and smoothly between 0 and -300V. Check that the "LED marked +" above the +/- button on the Stim probe is illuminated.

Press the +/- button on the Stim probe check that the stimulus pulse is again positive going. Check that the "LED marked +" next to the $\perp$ button on the Stim probe is illuminated.

Press the $\perp$ on the probe check that the Stim is turned off. Check that the LED above the Stim button on the control panel is not illuminated.

Briefly press in the **Rotary stimulus level control** on the probe and check that both the stim and green acquire LED,s briefly light on the control panel. A stim is generated and trace is acquired.

Press and hold in (for < 1s) the **Rotary stimulus level control** on the probe and check that both the stim and green acquire LED,s light and on the control panel. Check acquire and stim are now latched on, the trace on the left hand screen is constantly updated.

Briefly press in the **Rotary stimulus level control**, Check acquire and stim are now latched off.

Return the stimulus level to minimum.

Replace the 3k0 load with the 2k7 load and monitor across it with the CRO.

Press $\perp$ and gradually increase the stimulus level to maximum.

Check that when the stimulus intensity setting is approximately 270V, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red..

Return the stimulus level to minimum and press $\perp$ to turn the stimulator output off.

Replace the 2k7 load with the 3k0 load and monitor across it with the CRO.

Set the stimulus **Output** to **Current**, then click on **OK**. Press $\perp$ and gradually increase the stimulus level to maximum, 100mA.

Check on the CRO for a 300V stim pulse (100mA x 3k0) of 500 μ s duration every 200ms.

Rotate the stimulus level control over its full travel, and check that the amplitude of the stimulus pulse can be varied continuously and smoothly between 0 and 300V, (0 - 100mA).

Return the stimulus level to minimum and press $\perp$ to turn off the stimulator output.

Replace the 3k0 load with the 3k3 load and monitor across it with the CRO.

Press $\perp$ and gradually increase the stimulus level to maximum.

Check that when the stim intensity setting is approximately 90mA, a "**Electrical Stim has reported a Stim Delivery failure**" message is displayed, and the background to the stim intensity display turns red.

Return the stimulus level to minimum and press $\perp$ to turn the stimulator output off.

10.6.6 Systems with 2 External EMG Stim Probes

If the system has 2 optional external Stim Probes then the previous set of checks must be repeated.
If not go to the Speaker checks

Connect the second probe to the **Plinth stim A socket**

Press "stimulus" on the probe to turn off the stimulator check there is no output. Quit the application and shut down Windows. Disconnect the second Deluxe Stimulator Probe.

10.6.7 EMG Speaker Checks

Plinth tower system has internal speakers in the **Plinth** and **Flat screen display** or for Notebook system there are internal speakers in the **Notebook PC**.

Also for either system EMG Headphones or an external EMG speaker can be connected to the Plinth.

Set the Signal Generator to give a 10mV pk-pk 1KHz sinewave output. Connect the signal output to the red sockets on the amplifier and the signal ground to the green and black sockets joined together.

Adjust the amplifier gain to give a 2 div sinewave on the monitor traces.

Select the **Acquisition** drop-down menu and then select **Setup**. Select **Audio Setup** and then click in the **Audio On/Off** box to turn audio **on**. The plinth internal speaker will now be active, gradually increase the control panel **Volume** control.

Note:-There may also be a volume control on the Notebook PC or in the case of the Tower system on the monitor for the built in speakers this should be gradually increased. The Windows volume control on the task bar must not be muted and should be set to near maximum. To check the windows volume setting use the pointing device and click the speaker symbol at the right hand end of the task bar.

Check that the 1kHz tone can be heard from the internal loud speakers.

Check that the tone is clear and undistorted.

Vary the Signal Generator frequency from 100Hz to 10kHz and vary the volume. Check that the tone is clear and undistorted.

Now plug the (optional) external speakers or headphones into the EMG Audio output socket on the Plinth and repeat checks as above.

Return the **Volume** control to minimum.

Disconnect the Signal Generator from the Amplifier.

10.6.8 Tripple Footswitch Checks

Plug the tripple footswitch assembly into the 'Z' connector on the Plinth.

Briefly operate the **Acquire** footswitch. Check that the green LED next to the **Acquire** button on the Control Panel, flashes briefly.

Check that the active store trace is updated once.

If present, operate the **Next** footswitch.

Check that the next store trace has been made the active store.

Operate the **Acquire** footswitch again, holding it depressed for >3s. Check that the green LED next to the **Acquire** button on the Control Panel, remains illuminated. Check that the new active store trace is repeatedly updated

Briefly operate the **Acquire** footswitch again, and check that the green LED next to the **Acquire** button, turns off. Check that the active store trace stops updating.

If using the triple footswitch assembly, operate the programmable footswitch and check for a response on the display – this depends on how the footswitch function has been programmed, but normally results in the monitor or store screen becoming full screen size. Operate the footswitch once more to return to the original display.

10.6.9 Single Footswitch Checks

Connect the single footswitch (optional) assembly to the 'Z' connector on the Plinth. If you also have the tripple switch it can be connected to the free 9 way d socket on the single footswitch.

Briefly operate the **Acquire** footswitch. Check that the green LED next to the **Acquire** button on the control panel, flashes briefly.

Check that the active store trace is updated once.

Press the **NEXT** button on the control panel.

Check that the next store trace has been made the active store.

Operate the **Acquire** footswitch again, holding it depressed for >1s. Check that the green LED next to the **Acquire** button on the control panel, remains illuminated. Check that the new active store trace is repeatedly updated

Briefly operate the **Acquire** footswitch again, and check that the green LED next to the **Acquire** button, turns off. Check that the active store trace stops updating.

Disconnect the single Footswitch.

10.7 Triggering in / out for external sources and I/O INTERFACE (option)

Equipment required for this section:-

*Function Generator
Oscilloscope (CRO) - Hitachi
V1100/V1050 or similar.*

*Leads suitable to connect to the
Trigger I/O $\nabla \oplus \nabla$ connector on the
plinth*

OR

I / O INTERFACE (option)

Make connections to the required points on **Trigger I/O** $\nabla \oplus \nabla$ connector on the plinth the during the tests

Or if available

Plug the **I/O Interface box** into the **I Trigger I/O** $\nabla \oplus \nabla$ connector of the Synergy system.

Set the Function Generator frequency to 30Hz. Connect the TTL output of the Function Generator to the 1 $\ominus$ (Ext Trig1) BNC connector and also monitor the Function General output with CH2 of the CRO, triggering from the ∇ edge of this signal. Connect a 3k Ω load across Stim A -1 and monitor across it with CH1 of the CRO.

From the **Test Menu**, select **Motor NCV**, select **Electrical stim setup**, set stim to **select Ext Trig 1** and click on **Select**. Press **Stim** and increase **Stim A** intensity.

Check that CH1 of the CRO displays positive 200ms stim pulses, coincident with the positive edges of the Function Generator output.

Vary the Function Generator frequency and check that the Rep Rate is controlled by the Function Generator.

From the menu select **Stimulus / Stim Setup ...**. Click on **Stim Options** and set **External In Polarity** to -, click on **Ok**. Change **Polarity** to -, then click on **Ok**.

Check that CH1 of the CRO now displays negative 200ms stim pulses coincident with the negative edges of the Function Generator output.

Set the Function Generator frequency to 30Hz. Connect the TTL output of the Function Generator to the 2 $\ominus$ (Ext Trig2) BNC connector and also monitor the Function General output with CH2 of the CRO, triggering from the ∇ edge of this signal. Connect a 3k Ω load across Stim A -1 and monitor across it with CH1 of the CRO.

From the menu select **Acquisition / New Phase**, highlight **Ext Trig 2** and click on **Select**. Press **Stim** and increase **Stim A** intensity.

Check that CH1 of the CRO displays positive 200ms stim pulses, coincident with the positive edges of the Function Generator output.

Vary the Function Generator frequency and check that the Rep Rate is controlled by the Function Generator.

From the menu select **Stimulus / Stim Setup ...**. Click on **Stim Options** and set **External In Polarity** to -, click on **Ok**. Change **Polarity** to -, then click on **Ok**.

Check that CH1 of the CRO now displays negative 200ms stim pulses coincident with the negative edges of the Function Generator output.

10.7.1 External Trigger out checks
Select **Motor NCV**, select **Electrical stim setup**, Click on **Stim Options** and set **External Out Polarity** to +, click on **Ok**, **Ok**.

Monitor the 1 $\oplus$ (Aux Stim1) BNC connector with CH1 of the CRO, triggering from the ∇ edge of this signal.

Select **Ext Trig 1** and click on **Select**. Press **Stim**.

Check that CH1 of the CRO displays positive 100 μ s TTL pulses.

From the menu select **Stimulus / Stim Setup ...**. Click on **Stim Options** and set **External Out Polarity** to -, click on **Ok**, **Ok**.

Check that CH1 of the CRO now displays negative 100 μ s TTL pulses.

Monitor the 2 $\oplus$ (Aux Stim2) BNC connector with CH1 of the CRO, triggering from the ∇ edge of this signal.

From the menu select **Acquisition / New Phase**, highlight **Ext Trig 2** and click on **Select**. Press **Stim**.

Check that CH1 of the CRO displays positive 100µs TTL pulses.

From the menu select **Stimulus / Stim Setup** Click on **Stim Options** and set **External Out Polarity** to -, click on **Ok, Ok**.

Check that CH1 of the CRO now displays negative 100µs TTL pulses.

With the DMM monitor pin 2 wrt pin 4 of the $\oplus$ connector.

Check for a nominal DMM reading of +24V.

Monitor pin 1 with the CRO.

Check for a high TTL level.

?????????

10.7.2 Temperature Probe Input check

While in the **Sensory NCS** test which includes temperature measurement in the setup connect the probe and check that the room temperature is measured and displayed. Check the reading can be varied if you hold or breath on the probe.

The Temperature Probe Input on the amplifier, is designed for use with YSI series 400 or 4400 probes with resistance of 2253Ω at 25°C. Reusable and Disposable types available (see chapter 10)
Note: Disposable types cannot be connected directly, an extension/adaptor cable is required.

When the correct type of probe is connected to the input a range 15°C to 40°C with 0.1°C resolution, 0.2°C accuracy can be measured. If the temperature is outside this range then the display will read -----°C.

10.8 Parallel & Serial Port Checks

 **Peripheral equipment not supplied by Oxford Instruments should not be connected.**

10.8.1 Parallel Port

To perform these checks, the Windows printer driver for the printer being used must have been previously installed.

Connect the printer to the parallel port connector marked " " on the rear of the PC. Ensure it is loaded with paper and switch it on. From the **Task Bar** click on **Start**, select **Programs**, then select **Accessories**, then click on **WordPad**.

When **WordPad** has loaded, click on **File**, then **Open**. Select and load a document or text file *.doc or *.txt. When the file has loaded, click on the **Printer** icon and the document will be printed.

Check that the printer prints the document and that what is printed is correct.

Exit the WordPad application.

10.8.2 Serial COM Port

Make a "loop back" connector by shorting together pins 2 and 3 of a 9-way D type socket. Insert this connector, into the **COM** port on the rear of the PC.

Start the **Hyper Terminal** application, (**Start / Programs / Accessories / Hyper Terminal**). Double click on the **Hypertrm.exe** icon.

When asked to enter a **Name** for the **Connection Description**, type **Test** then click on **OK**.

In the **Phone Number** window, set **Connect using** to **Direct to Com**, click on **Ok**.

In the **COM Properties** window set :-

Bits per second 9600
Data bits 8
ParityNone
Stop bits 1
Flow controlNone

Click on **OK**.

Type any characters on the keyboard, and check that the characters typed appear in the Hyper Terminal window.

Remove the 'loopback' connector, and type on the keyboard.

Check that the characters typed no longer appear in the Hyper Terminal window.

Exit **Hyper Terminal**. When asked if you want to disconnect, click on **OK**. When asked if you want to save the session, click on **NO**.

10.8.3 Networking Checks (If you have more than one system)

The checks described in this section first check that the Tower PC can see the Notebook PC and vice versa.

A PCMCIA network module (PCMCIA) approved by the Notebook PCs manufacturer should be fitted into a PC Card Slot in the Notebook. This will normally be connected via a short lead to a pod (Media coupler for network). The pod will contain the larger connector required for the network connection.

Normally this will be a Network direct connection –with a CAT5 shielded (STP) Patch Cable - Crossover (RJ45 connectors)

When the two PC's are connected together, ensure that at least one directory is shared. To share a directory proceed as follows.

Start **Windows Explorer**, right click on a directory and then select **Sharing ...**. Click on **Shared As :**, then click on **Apply**, then **Ok**.

Start **Windows Explorer** on both systems and click on the + box next to the **Entire Network** icon. There will be a delay while the network is searched for connected systems.

Check that a list of connected systems appears in the right hand window.

Select a system sharing directories on the network, then select a directory on that system.

Check that the directory contents are displayed in the right hand pane.

Close down the Synergy Systems application and then Windows. Switch off the unit and disconnect all test equipment.

10.8.4 If a connection is required via a local network

You are first advised to have completed the checks described in the previous section. This will check that the Tower PC can see the Notebook PC and vice versa when directly connected.

Normally this will be a Network connection via a **hub using RJ45** connectors.

Note The STP cables must be the normal type without crossover.

For advice on **other methods** of network connection between the Synergy Systems contact your network administrator or contact Oxford Instruments Support.

When the two PC's are connected together, via the network ensure that at least one directory is shared. To share a directory proceed as follows.

Start **Windows Explorer**, right click on a directory and then select **Sharing ...**. Click on **Shared As :**, then click on **Apply**, then **Ok**.

Start **Windows Explorer** on both systems and click on the + box next to the **Entire Network** icon. There will be a delay while the network is searched for connected systems.

Check that a list of connected systems appears in the right hand window.

Select a system sharing directories on the network, then select a directory on that system.

Check that the directory contents are displayed in the right hand pane.

Close down the Synergy Systems application and then Windows. Switch off the unit and disconnect all test equipment.

10.9 EP Stim Checks

10.9.1 Visual Stimulus Checks

Plug the SVGA monitor into the visual EP Stim  connector on the right hand edge of the Plinth.

From the **Test Menu** select the appropriate **EP Tests folder**, then select the **VEP Pattern** test. From the **Stimulus / Stim. Setup ...** screen, set various **Pattern** types, **Sizes**, **Contrasts**, **Presentations**, **Masking** and **Fixation** size settings, each time clicking on **Ok** when set.

Check that the visual stimulus pattern displayed on the VGA monitor is correct for each setting.

Press the Control Panel **Stim.** button.

Check that the displayed pattern changes at the selected Rep. Rate.

Press **Stim.** on the Front Panel.

10.9.2 Audiometric Stimulus Checks

Plug the **Audiometric Headphone** set into the  connector on the right hand edge of the Plinth.

Click the **Test Menu** button and select the **CERA** test.

From the **Stimulus / Stim. Setup ...** screen check and if necessary set **Audio Type** to **Tone Burst**, **Intensity** to **100dB**, **Frequency** to **1kHz**. Turn **Masking On** and set **Side** to **Contralateral**, **Type** to **White Noise** and **Intensity** to **0dB**. Click on **Ok** when set.

Press the Control Panel **Stim.** button.

Check that a 1kHz tone at the set Rep. Rate can be heard from the left earphone and white noise in the right earphone.

Press the Control Panel **Stim.** button.

Click on the **Other Side** button and press the Control Panel **Stim.** button.

Check that a 1kHz tone can be heard from the right earphone and white noise in the left earphone.

Change **Masking** to **Narrow Band**. Select various **Frequencies**, **Intensities** and **Masking** levels.

Check that the frequency, and intensity of the tone and masking heard can be varied.

Click the **Test Menu** button and select the **BAER** test.

From the **Stimulus / Stim. Setup ...** screen check and if necessary set **Audio Type** to **Click**, **Intensity** to **100dB**, **Duration** to **0.1ms**. Turn **Masking On** and set **Side** to **Contralateral**, **Type** to **White Noise** and **Intensity** to **0dB**. Click on **Ok** when set.

Press the Control Panel **Stim.** button.

Check that a 'click' at the set Rep. Rate can be heard from the left earphone and white noise in the right earphone.

Press the Control Panel **Stim.** button.

Click on the **Other Side** button and press the Control Panel **Stim.** button. Set the stim. parameters as above.

Check that a 'click' can be heard from the right earphone and white noise in the left earphone.

Select various **Intensities** and **Masking** levels.

Check that the intensity of the 'click' and masking heard can be varied.

Close down the Synergy Systems application and then Windows. Switch off the system and disconnect all test equipment.

FIRMWARE HISTORY

11.1 Introduction

This chapter lists the programmed hardware devices used in the Synergy Systems. The lists includes all supported versions of the firmware up to the time of writing.

11.1.1 **Firmware in PIU** Amplifier board 035E001

PIC micro controller type 16C74A-20/L

In position M12 on Amplifier Board 035E001
Part number 035P001.

Decode and PAL type PZ5032-10A44

in position M35 in Amplifier Board 035E001
Part number 035P002.

USB and Stim Board 035E002

Microcontroller Firmware Flash

Rom Type AT49HLV010-90JC

In position M53 on the USB and Stim Board
035E002
Part number 035P003

Microcontroller decode PAL

Type PZ3032CS12BC

In position M42 on the USB and Stim Board
035E002
Part number 035P004 - Note this is a surface
mounted device that is not replaceable.

Internal Stim PIC

PIC type 16C74A-20/L

In position M54 on USB and Stim Board
035E002
Part number 035P005

11.2 Firmware in Stimulator Probe

11.2.1 **EMG Stim Controller 031P028**

Housed in one PIC type 16C74A-20/L in
position M5 on Low Voltage EMG Stimulator
board 031E015.

Version B00 : First supported issue.
Checksum :9460
Part number 031P028.

11.3 Firmware in Plinth

There is no removable firmware in the Plinth
the firmware is programmed into the plinth
during manufacture. The about Synergy
screen will display details of which version is
installed.

FAULT FINDING

This chapter may be used by the Service Engineer as a basis for fault finding in the Synergy Systems down to board /subassembly level. The "Fault Finding Table" is split into two columns. The left hand column shows the symptoms, and the right hand column indicates the area to look at first. **Page 6** onward deals with the **Plinth systems**.

12.1 Notebook System With PIU Fault Finding

Fault Symptom	Possible Fault(s)
Unit totally "dead"	– Mains plug fuse blown (if the plug is the type fitted with a fuse) – Mains lead damaged – No mains supply – Oxford Instruments Medical grade PSU failure, check DC output – Notebook PC's Power Supply failure, check DC output – D.C. supply power cables damaged /disconnected – D.C. supply small junction box damaged /disconnected
PC dead (no lights appear) Note:- The small fan at the back of the notebook PC is controlled by the processor temperature. Only runs when required.	– Poor connection or no mains supply or DC outputs as above – Discharged Batteries in the Notebook PC both standby and main. Note If the Notebook PC's Power Supply is connected and functioning correctly, then the Notebook PC can be run with no main battery in the PC. – See the Notebook PC battery state indicators – The PIU or PC is faulty possibly causing the supplies to shut down
RTC error messages	The Real Time Clock/Calender battery is discharged. Replacement required consult authorised PC agent.
No display	– Check the PC's Display Setup the choices are simultaneous, external or internal monitors. – Check the PC's power management settings. – LCD display failed. Does external Monitor work? Test monitor on another PC. – PC faulty
Windows operating system is not loaded at switch-on	– System software has become corrupted (refer to Windows documentation) – Hard disk is faulty – IDE interface on PC is faulty – BIOS settings on PC have changed
Error messages displayed during start-up sequence	– System does not recognise a hardware or software configuration (refer to Windows documentation or on-line help) – Windows or applications software corrupted
Applications software not loaded at switch-on	– Application has been removed from Windows "StartUp" program group – Application software has been corrupted
External Pointing device (e.g. mouse) inoperative	– Device has become disconnected – Device is faulty – Windows has not recognised device at switch-on – Windows software driver for device has become corrupted – Interface in PC faulty
Internal Pointing device inoperative	– Device is faulty – Windows has not recognised device at switch-on – Windows software driver for device has become corrupted – Interface in PC faulty

Fault Symptom	Possible Fault(s)
Keyboard inoperative (Internal or external Optional)	– If external Keyboard used it may be unsuitable or disconnected – Internal Keyboard faulty – Windows has not recognised keyboard at switch-on – Windows software for keyboard has become corrupted – Interface in PC faulty
Patient Interface Unit inoperative	– Windows not seeing it via USB – Applications software corrupted – Patient Interface Unit has become disconnected – Patient Interface Unit is faulty – USB input on the notebook PC is faulty
Patient Interface Unit controls do not work	– See above section
No patient signals displayed	– Applications software corrupted – Amplifier in Patient Interface Unit faulty (try with Amp Cal signal) – Patient connections or leads faulty – USB problems (are controls on Patient Interface Unit working. If so then the USB is probably OK).
No Amp Cal signal displayed	– Applications software corrupted – Cal circuit faulty (try with patient signal) – Patient Interface Unit lead faulty – USB communication faulty
Unable to trigger signals	– Applications software corrupted – Controls or switches on Patient Interface Unit faulty – Poor or noisy signal – Try triggering on opposite polarity
No audio signal to loudspeakers	– One of the volume settings has been altered – Applications software corrupted – Loudspeakers or sound system disabled or faulty – If using an external speaker check connections or swap speaker – Patient Interface Unit faulty
No EMG Stimulus output	– Windows does not recognise assembly – Patient Interface Unit Applications software corrupted – EMG Stimulator circuit in PIU or stimulator probe faulty – Connections to PIU or Internal cables notebook PC faulty
Displayed EMG stimulus level does not change as control adjusted	– Applications software corrupted – Controls on Patient Interface Unit faulty – Stimulator probe faulty
Unable to print	– Printer "off-line" it must be "on line" – Applications software corrupted (try printing Windows printer test page) – Printer faulty – Printer data lead faulty or disconnected
Unable to read CD-ROM	– Disk not fitted in drive correctly – Windows not recognising CD-ROM drive at switch-on – Faulty PC
USB not communicating with PIU	– USB disabled on PC – Wrong drivers loaded
Stimulator probe not functioning.	Check setting in stim setup. Select stim B as in section 6.10

12.2 Tower System With PIU Fault Finding

Fault Symptom	Possible Fault(s)
Unit totally "dead"	– Mains fuses blown – Mains lead damaged – No mains supply – ISO800 Isolating transformer failure or fuses – D.C. supply leads damaged/disconnected
PC Tower dead (no fan noise and no lights appear in Tower on/off switch)	– Poor connection or no supply from Isolating Transformer unit to tower – Tower internal PSU faulty or some item in Tower is faulty possibly short circuit and causing the PSU to shut down
No display	– SVGA monitor or connections. – Monitor output from the PC motherboard may have failed – PC motherboard faulty – Internal cables disconnected – Hard disk is faulty – IDE interface on PC motherboard is faulty – BIOS settings on PC motherboard have changed
Windows operating system is not loaded at switch-on	– System software has become corrupted (refer to Windows documentation) – Hard disk is faulty – IDE interface on PC motherboard is faulty – BIOS settings on PC motherboard have changed
Error messages displayed during start-up sequence	– System does not recognise a hardware or software configuration (refer to Windows documentation or on-line help) – Windows or applications software corrupted
Applications software not loaded at switch-on	– Application has been removed from Windows "StartUp" program group – Application software has been corrupted
Pointing device (e.g. mouse) inoperative	– Device has become disconnected – Device is faulty – Windows has not recognised device at switch-on – Windows software driver for device has become corrupted – Interface on PC motherboard faulty
Keyboard inoperative	– Keyboard has become disconnected – Keyboard is faulty – Windows has not recognised keyboard at switch-on – Windows software for keyboard has become corrupted – Interface on PC motherboard faulty
Patient Interface Unit inoperative	– Windows not seeing it via USB – Applications software corrupted – Patient Interface Unit has become disconnected – Patient Interface Unit is faulty – USB input on the notebook PC is faulty
Patient Interface Unit controls do not work	– See above section
No patient signals displayed	– Applications software corrupted – Amplifier in Patient Interface Unit faulty (try with Amp Cal signal) – Patient connections or leads faulty – USB problems (are controls on Patient Interface Unit working)
No Amp Cal signal displayed	– Applications software corrupted – Cal circuit faulty (try with patient signal) – Patient Interface Unit lead faulty – USB communication faulty

Fault Symptom	Possible Fault(s)
Unable to trigger signals	– Applications software corrupted – Controls or switches on Patient Interface Unit faulty – Poor or noisy signal – Try triggering on opposite polarity
No audio signal to loudspeaker	– Applications software corrupted – Loudspeaker disconnected or faulty (try another loud speaker)
No EMG Stimulus output	– Windows does not recognise USB and PIU – Applications software corrupted – EMG Stimulus circuit or stim probe faulty (if in use) – PIU assembly faulty
Unable to print	– Printer data lead faulty or disconnected – Printer "off-line" – Applications software corrupted (try printing Windows printer test page) – PC motherboard BIOS parameters corrupted – Printer faulty
Unable to read CD-ROM or Optical Disk	– Disk not fitted in drive correctly – Disk damaged – Windows not recognising CD-ROM drive at switch-on – Power cable to drive disconnected – Data cable to drive disconnected – Faulty mother board.
Error 504 – Missing headbox device	Check that the amplifier is connected ensure that the system is switched off before disconnecting or connecting an amplifier.
Error 114 – failed to allocate an amplifier channel	The selected test has been configured to use more channels than the number currently available.

12.3 Suite System With PIU Fault Finding

For fault finding on the Suite System consult the previous two sections as the Suite System contains all of the Notebook and the Tower components.

Fault Symptom	Possible Fault(s)
No Direct network connection possible between Synergy systems	-In Notebook PC the PCMCIA network card not correctly seated. -Media coupler not correctly connected to the PCMCIA network card -Incorrect or damaged Network cable it must be a "CAT5 shielded (SPT) patch cable - cross over type with RJ45 connectors". In the Tower PC the Network card is faulty No shared files
No connection via a customers network	-The network is not of a type approved by Oxford Instruments Medical Ltd. (Any advice may be chargeable). You may not have the required permission to connect consult, local network administrator. In Notebook PC the PCMCIA network card not correctly seated. -Media coupler not correctly connected to the PCMCIA network card -Incorrect or damaged Network cable it must be "CAT5 shielded (SPT) patch cable - with RJ45 connectors". In the Tower PC the Network card is faulty No shared files
Windows Explorer can see the other PC but no Synergy Network connection	Configuration of shared files and databases on either PC may be incorrect. See user manual for details.

12.4 Notebook System With Plinth Fault Finding

Fault Symptom	Possible Fault(s)
Plinth is totally "dead", LED not light on the front of the plinth, Fan not rotation at the back of the plinth. No LED light on the control panel.	– Mains plug fuse blown (if the plug is the type fitted with a fuse) – Mains lead damaged – No mains supply – If an Isolating transformer is in use then check its fuses and the isolated mains outputs from the Transformer. – The plinth internal Medical grade Power Supply may have failed, check DC output. Is the plinth front LED on. – Note The amplifier, Control Panel and Stim Probe are all protected by Poly fuses so even if they were to be faulty they should not cause the supplies in the Plinth to shut down
Notebook PC dead (no lights appear) Note:- The small fan at the back of the notebook PC is controlled by the processor temperature. Only runs when required.	– No power or poor connection from the DC to DC "Universal Auto/AirTM Power Adaptor". – Poor connection or no mains supply to plinth. – Discharged Batteries in the Notebook PC both standby and main. Note If the DC to DC Adaptor is connected and functioning correctly, then the Notebook PC can be run with no main battery in the PC. – See the Notebook PC battery state indicators – The DC to DC Adaptor or the small convertor connecting the supply to the Notebook may be faulty. Or the PC may be faulty possibly causing the other supplies to shut down
Control panel dead (no lights appear)	– Poor connection or no DC supply – The control panel is faulty possibly causing the supplies to shut down
RTC error messages	The Real Time Clock/Calendar battery is discharged. Replacement required consult authorised PC agent.
No display	– Check the PC's Display Setup the choices are simultaneous, external or internal monitors. – Check the PC's power management settings. – LCD display failed. Check PC with external Monitor – PC faulty
Windows operating system is not loaded at switch-on	– System software has become corrupted (refer to Windows documentation) – Hard disk is faulty – IDE interface on PC is faulty – BIOS settings on PC have changed
Error messages displayed during start-up sequence	– System does not recognise a hardware or software configuration (refer to Windows documentation or on-line help) – Windows or applications software corrupted
Applications software not loaded at switch-on	– Application has been removed from Windows "StartUp" program group – Application software has been corrupted
Pointing device in control panel inoperative	– Device has become disconnected from PC – Device is faulty – Interface in PC faulty
Internal Pointing device in Notebook inoperative	– Device is faulty – Interface in PC faulty
Alternative Pointing device to the pointing device in the Control panel (mouse if used) - inoperative	– Device has become disconnected from PC – Device is faulty – Windows has not recognised device at switch-on – Windows software driver for device has become corrupted – Interface in PC faulty

Fault Symptom	Possible Fault(s)
Keyboard inoperative (Internal or external Optional)	– If external Keyboard used it may be unsuitable or disconnected – Internal Keyboard faulty – Windows has not recognised keyboard at switch-on – Windows software for keyboard has become corrupted – Interface in PC faulty
Plinth inoperative	– Windows not seeing it via USB – Applications software corrupted – Plinth has become disconnected – Plinth is faulty – USB input on the notebook PC is faulty
Control panel controls do not work	– See above section
No patient signals displayed	- Applications software corrupted – Amplifier in faulty (try with Amp Cal signal) – Patient connections or leads faulty – Amplifier connection problems – USB to Plinth problems (is Control Panel still working. If so then Plinth -USB to PC is probably OK).
No Amp Cal signal displayed	– Applications software corrupted – Cal circuit faulty (try with patient signal) – Amplifier or lead faulty – USB communication faulty
Unable to trigger signals	– Applications software corrupted – Controls or switches on Control Panel faulty – Poor or noisy signal – Try triggering on opposite polarity
No audio signal to loudspeakers	– One of the volume settings has been altered – Applications software corrupted – Loudspeakers or sound system disabled or faulty – If using an external speaker check connections or swap speaker – Plinth faulty
No EMG Stimulus output	– Windows does not recognise assembly – Control Panel Applications software corrupted – EMG Stimulator circuit in Control Panel or stimulator probe faulty – Connections to Control Panel or Internal cables notebook PC faulty
Displayed EMG stimulus level does not change as control adjusted	– Applications software corrupted – Controls on Control Panel faulty – Stimulator probe faulty
Unable to print	– Printer "off-line" it must be "on line" – Applications software corrupted (try printing Windows printer test page) – Printer faulty – Printer data lead faulty or disconnected
Unable to read CD-ROM	– Disk not fitted in drive correctly – Windows not recognising CD-ROM drive at switch-on – Faulty PC
USB not communicating with Plinth	– USB disabled on PC – Wrong drivers loaded
Stimulator probe not functioning.	Check setting in stim setup and triggering setup. Select stim A or B as required

Fault Symptom	Possible Fault(s)
Incorrect level of audio output or no audio output from EP Plint	– Windows does not recognise EP Stimulator board via the USB interface in the Plinth – Applications software corrupted – EP Stimulator board in Plinth is faulty – Calibration parameters stored on EP Stimulator board corrupted – Internal cable disconnected or faulty – Headphones faulty or connections via connector unit faulty – PC USB interface faulty
No visual output from EP stimulator in plinth	– Windows does not recognise EP Stimulator board via the USB interface in the Plinth – Applications software corrupted – EP Stimulator board in the Plinth faulty – VEP Monitor connections via connector unit faulty – VEP Monitor faulty – USB interface in PC faulty

12.5 Tower System With Plinth Fault Finding

Fault Symptom	Possible Fault(s)
Plinth is totally "dead", LED not light on the front of the plinth	– Mains fuses blown – Mains lead damaged – No mains supply – ISB-100W Isolating transformer failure or fuses Note when checking the fuses, remember that the input voltage setting on the ISB-100W Isolating transformer is changed by inverting the fuse carrier. Care must be taken to replace the carrier correctly according to the local mains voltage. Plinth Power supply failure. – Note The amplifier, Control Panel and Stim Probe are all protected by Poly fuses so even if they were to be faulty they should not cause the supplies in the Plinth to shut down
PC Tower dead (no fan noise and no lights appear in Tower on/off switch)	– Poor connection or no supply from Isolating Transformer unit to tower – Tower internal PSU faulty or some item in Tower is faulty possibly short circuit and causing the PSU to shut down
No display	– Flat screen display failed or poor connections. – Monitor output from the PC motherboard may have failed – PC motherboard faulty – Internal cables disconnected – Hard disk is faulty – IDE interface on PC motherboard is faulty – BIOS settings on PC motherboard have changed
Windows operating system is not loaded at switch-on	– System software has become corrupted (refer to Windows documentation) – Hard disk is faulty – IDE interface on PC motherboard is faulty – BIOS settings on PC motherboard have changed
Error messages displayed during start-up sequence	– System does not recognise a hardware or software configuration (refer to Windows documentation or on-line help) – Windows or applications software corrupted
Applications software not loaded at switch-on	– Application has been removed from Windows "StartUp" program group – Application software has been corrupted
Pointing device (In Control Panel) inoperative	– Device has become disconnected – Device is faulty – Windows has not recognised device at switch-on – Windows software driver for device has become corrupted Try connecting another mouse to the PC. – Interface on PC motherboard faulty
Keyboard inoperative	– Keyboard has become disconnected – Keyboard is faulty- Try swap – Windows has not recognised keyboard at switch-on – Windows software for keyboard has become corrupted – Interface on PC motherboard faulty
Amplifier inoperative	– Windows not seeing Amplifier via USB – Applications software corrupted – Plinth or amplifier has become disconnected – Plinth or amplifier are faulty – USB input on the PC is faulty
Control Panel does not work	– Windows not seeing Control Panel via USB – Applications software corrupted – Plinth or Control Panel has become disconnected – Plinth or Control Panel is faulty – USB input on the PC is faulty See above section

Fault Symptom	Possible Fault(s)
No patient signals displayed	– Applications software corrupted – Amplifier in or connections are faulty (try with Amp Cal signal) – Patient connections or leads faulty – Plinth to USB problems (is control panel working)
No Amp Cal signal displayed	– Applications software corrupted – Cal circuit faulty (try with patient signal) – Amplifier lead faulty – USB communication faulty
Unable to trigger signals	– Applications software corrupted – Controls or switches on Control Panel faulty – Poor or noisy signal – Try triggering on opposite polarity
No audio signal to loudspeaker	– Applications software corrupted – Loudspeaker disconnected or faulty (try an external loud speaker) Plinth Faulty.
No EMG Stimulus output	– Windows does not recognise USB Plinth, control panel or stim probe – Applications software corrupted – EMG Stimulus circuit in control panel or stim probe faulty (if in use) – Plinth assembly faulty
Unable to print	– Printer data lead faulty or disconnected – Printer "off-line" – Applications software corrupted (try printing Windows printer test page) – PC motherboard BIOS parameters corrupted – Printer faulty
Unable to read CD-ROM or Optical Disk	– Disk not fitted in drive correctly – Disk damaged – Windows not recognising CD-ROM drive at switch-on – Power cable to drive disconnected – Data cable to drive disconnected – Faulty mother board.
Incorrect level of audio output or no audio output from EP Plint	– Windows does not recognise EP Stimulator board via the USB interface in the Plinth – Applications software corrupted – EP Stimulator board in Plinth is faulty – Calibration parameters stored on EP Stimulator board corrupted – Internal cable disconnected or faulty – Headphones faulty or connections via connector unit faulty – PC USB interface faulty
No visual output from EP stimulator in plinth	– Windows does not recognise EP Stimulator board via the USB interface in the Plinth – Applications software corrupted – EP Stimulator board in the Plinth faulty – VEP Monitor connections via connector unit faulty – VEP Monitor faulty – USB interface in PC faulty

Fault Symptom	Possible Fault(s)
Error 504 – Missing headbox device	Check that the amplifier is connected – ensure that the system is switched off before disconnecting or connecting an amplifier.
Error 114 – failed to allocate an amplifier channel	The selected test has been configured to use more channels than the number currently available.

12.6 Fault Finding Network Problems With Plinth Systems

For other fault finding on the Plinth System consult the previous two sections.

Fault Symptom	Possible Fault(s)
No Direct network connection possible between Synergy systems	-In Notebook PC the PCMCIA network card not correctly seated. -Media coupler not correctly connected to the PCMCIA network card -Incorrect or damaged Network cable it must be a "CAT5 shielded (SPT) patch cable - cross over type with RJ45 connectors". In the Tower PC the Network card is faulty No shared files
No connection via a customers network	-The network is not of a type approved by Oxford Instruments Medical Ltd. (Any advice may be chargeable). You may not have the required permission to connect consult, local network administrator. In Notebook PC the PCMCIA network card not correctly seated. -Media coupler not correctly connected to the PCMCIA network card -Incorrect or damaged Network cable it must be "CAT5 shielded (SPT) patch cable - with RJ45 connectors". In the Tower PC the Network card is faulty No shared files
Windows Explorer can see the other PC but no Synergy Network connection	Configuration of shared files and databases on either PC may be incorrect. See user manual for details.

SERVICING

13.1 Servicing Warnings

- ⚠ **For safety warnings about the use of the Tower or Notebook PC, refer the PC manufacturers User Manual.**
- ⚠ **Before performing any service operations on any of the Synergy Systems, ensure that the unit is switched off, disconnected from the and mains supply and Isolating Transformer if used.**
- ⚠ **Anti-static precautions must be observed when handling the boards in this system.**

13.2 Patient Interface Unit

Due to the number of small surface mounted components in the Patient Interface Unit there are no serviceable parts in the unit.

Follow the functional checks, fault finding guide and information provided in the Technical Overview Section to establish if the cause of the problem lies in the Patient Interface Unit. If so then exchange units are available from Oxford Instruments Medical Ltd or their distributors and agents.

13.3 Synergy Plinth Unit

Due to the number of small surface mounted components in the **Plinth** there are no serviceable parts.

Follow the functional checks, fault finding guide and information provided in the Technical Overview Section to establish if the cause of the problem lies in the **Plinth**. If so then exchange Plinth units are available from Oxford Instruments Medical Ltd or their distributors and agents.

Note that two variants of exchange **Plinth** units are available, one **with EP** and one **without EP** capability.

13.4 Warranty of PCs

Before performing any servicing function on the Notebook PC or the Tower PC, check to see if it is still covered by the PC manufacturers warranty. Any unauthorized tampering may invalidate the warranty.

13.5 Notebook's PC

The **Notebook PC is not user serviceable**. Any repairs required to the notebook should be carried out by the manufacturer or their appointed agents.

The Notebook's PC User Manual describes how to replace batteries and minor subassemblies in the event of a fault occurring.

It also recommends the methods for limited dismantling of the notebook in order to expand or upgrade the unit.

You are advised to follow the advice in the Notebook's PC User Manual.

13.5.1 PC Additional Memory Module installing or Replacing.

Refer the Notebook's PC User Manual.

13.5.2 Installing a PCMCIA Card **Refer the Notebook's PC User Manual.**

After installing a card refer to the cards documentation and check the configuration in the computer's Hardware Setup is correct for the card.

13.5.3 Removing a PCMCIA Card **Refer the Notebook's PC User Manual.**

Before removing a PC card refer to the cards documentation for procedures and use the Windows PC Card Properties utility to deselect the card. To access the PC Card Properties utility, click Start, Settings, Control Panel then double click the PC Card Properties icon.

For physical removal of a PC card refer the Notebook's PC User Manual.

13.6 Tower System

Before performing any servicing function on the PC tower, check to see if it is still covered by the PC manufacturers warranty. Any unauthorized tampering may invalidate the warranty.

You are advised to follow the advice in the Tower PC User Manual. This describes the recommended method for dismantling the Synergy Tower in order to upgrade the unit, or to replace subassemblies in the event of a fault occurring.

CUSTOMER OPTIONS AND SPARES

This chapter lists the hardware, replacements, spares and software options available for the Synergy Systems All lists contain the *Oxford Instruments* part numbers for these items that can be ordered from *Oxford Instruments* or your local distributor.

14.1 Common Hardware Spares and Software to all systems

14.1.1 Stimulator probes and spares

Electrical Stimulator Probe Kit External includes:-

Probe Assembly, probe head, Plain shafts, shafts for felt pads and felt pads ...031K025

Electrical Stimulator Probe Spares

Probe head with Plain shafts 031D035

Probe head with Plain shafts 031D035

Probe head with Plain shafts 031D035

Shafts for Adult felt pads..... 031Y119

10 felt pads (Large).....53081

14.1.2 Temperature probes

Temperature Probe (Reusable) 031S017

Temperature Probe (Disposable) 900X115

Extension/ Adapter Lead for Disposable

Temperature Probes 900X115

(Lead is Reusable) 031S018

14.1.3 Common System Hardware and Peripherals (options in some systems)

Arm and clamp 035B002

Desk mount and clamp 035B003

Laser Printer110V CP110

Laser Printer220V CP84

Printer cable 3 m (screened) PS1285

Printer cable 2m(screened) PS1361

Single Footswitch ST502

14.1.4 Synergy Systems Software Packages

Synergy Software(standard) 035P001

QEMG Software(Option) 031P007

SFJ Software(Option) 031P008

CD Electronic Myoanatomic Atlas v1
guidance on test methods APL345

CD Electronic Myoanatomic Atlas v2
typical test results examples APL430

Microsoft Software

Windows 2000 Prof (English).....CP289

Windows 2000 Prof (German) CP290

Windows 2000 Prof (Italian) CP291

Windows 2000 Prof (Spanish).....CP293

Windows 2000 Prof (French) CP292

Microsoft

Office Prof 2000 (English) CP233

Office Prof 2000 (German) CP235

Office Prof 2000 (Italian) CP237

Office Prof 2000 (Spanish) CP236

Office Prof 2000 (French) CP234

The Synergy Systems running Synergy Software Version 9.1 and greater must use Windows Prof 2000 and Office Prof 2000.

Note- In the future we will supply the latest Microsoft products against these part numbers. Check their compatibility with other software on your PC before purchase as upgrades may be required.

14.1.5 Patient Interface Unit (PIU)

PIU 035C001
Plus you also need the appropriate label kit

Label kit (TECA English) 035K001

Label kit (Medelec English) 035K002

Label kit (Medelec French) 035K003

Label kit (Medelec Spanish) 035K010

Label kit (Medelec Italian) 035K011

Label kit (Medelec German) 035K012

Label kit (Medelec Symbols) 035K013

Label kit (TECA Symbols) 035K017

14.1.6 Medical Grade PSU and junction box Assembly

Medical grade PSU and junction box Assembly 035C005
Plus you also need the appropriate **label kit**

Label kit (TECA English)	035K001
Label kit (Medelec English).....	035K002
Label kit (Medelec French)	035K003
Label kit (Medelec Spanish).....	035K010
Label kit (Medelec Italian)	035K011
Label kit (Medelec German)	035K012
Label kit (Medelec Symbols)	035K013
Label kit (TECA Symbols)	035K017

Note :-The Following are required for Notebook PIU System and for Notebook in Suite System

Y Mains lead (USA/ canada)	035S005
Y Mains leads (UK).....	035S006 + PS101
Y Mains leads (France, Germany, Portugal, Belgium & Spain)	035S006 + PS1374
Y Mains leads (Italy)	035S006 + PS1375
Y Mains lead (Rest of world)	035S006

14.1.7 Spares for PIU Notebook Systems

Lap top PC (TECA).....	CP207
Lap top PC (ROW Medelec)	CP195
Lap top PC (French)	CP208
Lap top PC (Spanish)	CP209
Lap top PC (Italian).....	CP210
Lap top PC (German).....	CP211
Notebook Stand and Arm.....	035B001
Carry case (Medelec ROW) version	CV27
Carry case (TECA) version	CV28
PCMCIA Network Card	CP212
Network cable(cross over type for direct links between two PC,s only)	PS1378

14.2 Spares for PIU Tower systems

Trolley Kit	041B005
ISO800 Isolating Transformer	041D002
Mains leads (USA, Canada).....	034D018
Mains leads (UK)	PS101, PS1323
Mains leads (French, Spanish, German & Portuguese).....	PS1355
Mains leads (Italian).....	PS1356
Mains leads (Rest of World)	PS1323
1 metre Power lead, ISO800 to PC, Medical Power Supply, Printer	
USA / Canada	034D019
Rest of World	PS1324
2 metre Power lead, ISO800 to Monitor	
USA / Canada	034D020
Rest of World	034S003
Network Card (PCI Combi)	CP150
Network cable(cross over type for direct links between two PC,s only)	PS1378
Monitor 17" inc speakers.....	900X117
Monitor clamps.....	MI 1120
Monitor Flat panel inc speakers.....	900X193
Memory 64Mb	IC1093
Modem external (UK only)	CP132
Keyboards (English).....	MI 1083
Keyboards (French).....	MI 1084
Keyboards (Spanish)	MI 1085
Keyboards (Italian)	MI 1086
Keyboards (German)	MI 1087
Keyboards (Portuguese).....	MI 1088
Keyboards (USA).....	MI 1095

14.3 Spares for Suite PIU System

See Notebook and Tower spares sections .

14.4 Spares for Plinth Systems

Labeling variation of Spare Plinth	PLINTH with EMG and EP	PLINTH with EMG only no EP
ENGLISH MEDELEC	040K025	040K033
SYMBOLS MEDELEC	040K026	040K034
FRENCH MEDELEC	040K027	040K035
GERMAN MEDELEC	040K028	040K036
ITALIAN MEDELEC	040K029	040K037
SPANISH MEDELEC	040K030	040K038
ENGLISH TECA	040K031	040K039
SYMBOLS TECA	040K032	040K040

Other Spares for Plinth Systems	Part number
Isolating Transformer ISB100W for Plinth Tower Systems (option for Notebook systems)	TM155
DC to DC "Universal Auto/Air TM Power Adaptor" (Supplies DC power from Plinth to Notebook)	CP310
2 Channel Amplifier	040K010S
5 Channel Amplifier	040K011S
10 Channel Amplifier	040K012S
Trolley	
Single Footswitch	ST502
Tripple Footswitch	ST503

14.4.2 Spare Control Panels For Plinth Systems

Labeling variation of Spare Control Panel	Cable length		
	1 Metre	2.5 Metres	5 Metres
English Medelec	040K041	040K049	040K057
Symbols Medelec	040K042	040K050	040K058
French Medelec	040K043	040K051	040K059
German Medelec	040K044	040K052	040K060
Italian Medelec	040K045	040K053	040K061
Spanish Medelec	040K046	040K054	040K062
English TECA	040K047	040K055	040K063
Symbols TECA	040K048	040K056	040K064

Cable Management on the Trolley

Draft in progress of this section.

Index

A

Amplifier Checks . . . Chp 9-Pg 3, Chp 10-Pg 3
 Amplifier Specification Chp 2-Pg 1
 Calibration Signal Chp 2-Pg 1, Chp 3-Pg 3
 Filters Chp 2-Pg 1, Chp 3-Pg 3
 Headbox Connections. Chp 2-Pg 1, Chp 3-Pg 3
 Impedance Test Chp 3-Pg 3
 Performance. . . Chp 2-Pg 1, Chp 3-Pg 3
 Sensitivity . . . Chp 2-Pg 1, Chp 3-Pg 3
 Applications Software Chp 1-Pg 3

B

Brief Description of parts . . . Chp 4-Pg 23

C

Calibration Signal Chp 2-Pg 1
 Cautions and Warnings. Chp 4-Pg 1
 Compliance with EN60601-1 . . . Chp 4-Pg 1
 Connecting Notebook System . . Chp 4-Pg 2
 Connecting PIU Notebook System Chp 4-Pg 2
 Connecting PIU Suite System . . Chp 4-Pg 4
 Connecting PIU Tower System . . Chp 4-Pg 3
 Connecting Plinth Notebook System . . Chp 4-Pg 9
 Connecting Plinth Notebook system Plus Isolation Transformer Chp 4-Pg 10
 Connecting Plinth Tower System Chp 4-Pg 11
 Connection of accesories to Plinth System Chp 4-Pg 15
 Controls. Chp 4-Pg 24
 Cooling. Chp 4-Pg 5

E

Electrical Stimulator
 Stimulus Duration Chp 2-Pg 2, Chp 3-Pg 5
 Electrical Stimulator in Control panel Specification Chp 3-Pg 4
 Electrical Stimulator Specification Chp 2-Pg 2
 Current Output Chp 2-Pg 2, Chp 3-Pg 4
 Voltage Output Chp 2-Pg 2, Chp 3-Pg 4

Ext Stim Probe Checks Chp 9-Pg 5, Chp 10-Pg 6

F

Fault Finding Chp 12-Pg 1
 Functional tests for PIU Systems. Chp 9-Pg 1
 Functional Tests for Plinth Systems. . . Chp 10-Pg 1
 Fuses for ISB-100W Chp 4-Pg 22
 Fuses for Plinth Chp 4-Pg 23

G

Graphical User Interface Chp 1-Pg 1

H

Handbook Scope Chp 4-Pg 1

I

Information Symbols Chp 4-Pg 16
 Information Symbols for Plinth Chp 4-Pg 18
 Inspection and assembly. Chp 4-Pg 20
 Installation Chp 4-Pg 20
 Installing Plinth Systems. Chp 4-Pg 22
 Internal Stim checks Chp 9-Pg 4, Chp 10-Pg 6

K

Key to Numbers of Plinth System connection Drawings (A4). Chp 4-Pg 12
 Key to PIU system Connection Drawings Chp 4-Pg 7
 Key to PIU System Drawings(A4) Chp 4-Pg 6
 Key to Plinth Connection Drawings Chp 4-Pg 13

L

Language Support . . Chp 2-Pg 2, Chp 3-Pg 7

M

Mains supply
 Cable Chp 4-Pg 20, Chp 4-Pg 21
 Colour coding Chp 4-Pg 20, Chp 4-Pg 21
 Medical Grade Power Supply . . Chp 2-Pg 1

N

Notebook System Connection. . . Chp 4-Pg 2

O

Operating Conditions Chp 2-Pg 3, Chp 3-Pg 7

P

Patient Interface Unit(PIU). Chp 1-Pg 1, Chp 6-Pg 1.

PCMIA cards. Chp 13-Pg 1

PIU Mains supply & connections

 Cable. Chp 4-Pg 22

Power Supply

 Specification Chp 2-Pg 1

Protective earth connection. . Chp 4-Pg 20, Chp 4-Pg 21

Q

Quality Standards . Chp 2-Pg 3, Chp 3-Pg 8

R

Repairs to Notebook PC Chp 13-Pg 1

Routine maintenance Chp 4-Pg 23

Routine Maintenance

 Cleaning Chp 4-Pg 23

S

Safety Checks

 PIU Notebook Leakage. . . Chp 7-Pg 4

 PIU Tower Stim tests . . . Chp 7-Pg 15

 PIU Tower tests. Chp 7-Pg 10

 Plinth Leakage Current. . . Chp 8-Pg 6

Safety Standards . . Chp 2-Pg 3, Chp 3-Pg 8

Size and Weight . . Chp 2-Pg 3, Chp 3-Pg 7

Software Packages.

 Test software options. . . Chp 14-Pg 1

Spares. Chp 14-Pg 1

Specification of Amplifiers for Plinth System Chp 3-Pg 3

Specification of EP Stimulator. . Chp 3-Pg 5

Suite System Connection Chp 4-Pg 4

Symbols Chp 4-Pg 16

T

Task Bar Chp 1-Pg 4

Temperature Probe checks Chp 9-Pg 4, Chp 10-Pg 5

Temperature Probes Chp 2-Pg 2, Chp 3-Pg 4

Tower System Connection . . . Chp 4-Pg 3

V

Verify System Functions . . Chp 9-Pg 1, Chp 10-Pg 1

W

Warning Symbols Chp 4-Pg 16

Warnings. Chp 4-Pg 5